

JIS

JAPANESE INDUSTRIAL STANDARD

**Test methods for
printed wiring boards**

JIS C 5012—1993

Translated and Published

by

Japanese Standards Association

Printed in Japan

In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

JAPANESE INDUSTRIAL STANDARD

J I S

Test methods for printed wiring boards

C 5012-1993

1. Scope This Japanese Industrial Standard specifies the methods of test for printed wiring boards principally for use in electronic apparatus (hereafter referred to as "printed boards").

Remarks 1. The printed boards to be dealt with in this Standard are single-sided, double-sided and multi-layer printed wiring boards, irrespective of their method of manufacture. Excluding flexible printed wiring boards, flex-rigid printed wiring boards and metal cored printed wiring boards.

2. The standards cited in this Standard are shown in Attached Table 1.

3. The International standards corresponding to this Standard are given below.

IEC 326-2 (1990) Printed boards. Part 2: Test methods

IEC 326-4 (1980) Printed boards. Part 4: Specification for single and double sided printed boards with plain holes

IEC 326-5 (1980) Printed boards. Part 5: Specification for single and double sided printed boards with plated-through holes

IEC 326-6 (1980) Printed boards. Part 6: Specification for multilayer printed boards

2. Definitions For the purpose of this Standard the principal definitions specified in JIS C 0010 and JIS C 5603 shall apply.

3. Atmospheric conditions for testing

3.1 Standard atmospheric conditions for testing Unless otherwise specified in the relevant detail specification, the tests shall be carried out under the standard atmospheric conditions (a temperature of 15°C to 35°C, a relative humidity of 25 % to 85 % and an air pressure of 86 kPa to 106 kPa) specified in 5.3.1 (Standard range of atmospheric conditions) of JIS C 0010. If doubt arises on the decision of the test under this standard conditions or if specially required, the atmospheric conditions specified in 3.2 of this standard shall be employed.

If it is difficult to carry out the tests under this standard conditions, the tests may be carried out under other conditions than this standard conditions unless doubt arises on the decision.

3.2 Standard atmospheric conditions for referee tests The standard atmospheric conditions for referee tests shall be the standard atmospheric conditions for referee tests specified in 5.2 (Standard atmospheric conditions for referee tests) of JIS C 0010 [Conditions of symbol I Grade 2 (a temperature of $20 \pm 2^\circ\text{C}$, a relative humidity of 60 % to 70 % and an air pressure of 86 kPa to 106 kPa)].

4. Specimen

4.1 Preparation of specimen Specimens shall be prepared in accordance with (1) or (2). The specimen shall be handled carefully in order to avoid contamination of surface by oils, sweat, etc.

- (1) Method by sampling Some boards are sampled from the actual boards for use to prepare specimens. If the shape and dimensions are specified in the relevant detail specification, the sampled board shall be cut to meet the specification in such a manner that the performance is not affected.

Further, if test coupons are provided, they may be employed as specimens.

- (2) Method to prepare test pattern The specimens with the test patterns specified in 4.2 shall be manufactured from the same materials and in the same manufacturing process as those of printed boards to be subjected to tests.

4.2 Test pattern The dimensions and pattern shapes shown, in Attached Figs. 1 and 2 shall be used according to the kind of printed board.

5. Preconditioning The preconditioning shall be carried out according to the provision of relevant detail specification, as stated in (1) or (2) below.

- (1) The specimen is allowed to stand under the standard conditions for 24 ± 4 h.
- (2) The specimen shall be allowed to stand in a thermostatic chamber at $85 \pm 2^\circ\text{C}$ for 60 min, and then allowed to stand under the standard test conditions for 24 ± 4 h.

6. Tests for appearance, microsection and dimensions

6.1 Appearance In the appearance test, visually or with a magnifier confirm the kind of printed board by comparing with the detail specification, and examine the appearance, finish, pattern, etc.

In the case of observing the finished state of specimen used for the microsection, generally embed the specimen into epoxy or polyester resin, set the resin, cut the part of specimen to be observed, grind the cut surface and then examine the ground surface by using a microscope with a magnification of about 250.

6.2 Microsection test In the microsection test, the internal conditions, appearance, dimensions, etc. of the plated-through holes, conductors and printed boards are checked as specified in the detail specification.

- (1) Equipment The equipment shall be a microscope which can measure the thickness of plating with an accuracy of 0.001 mm or better, or an apparatus which has at least equal accuracy.

- (2) Materials The materials shall be mold release agents, potting resins, abrasive cloth (#180, #400, #1000, etc.), abrasive paper (#180, #400, #1000, etc.) and abrasives (alumina, chromium oxide, etc.).
- (3) Preparation of specimen The specimen shall be carefully cut in adequate size not to give damage on the observing portion and potted using a suitable potting resin. Coarse grinding of specimen shall be carried out by using the abrasive cloth or paper starting from coarse grain size then moving to finer ones. Then fine grinding shall be made on the felt of rotating grinding machine with the abrasive poured. The polished surface shall fall within 85° to 90° to the layer.

When the thickness of plating on through hole is measured, the diameter of hole appearing on the microsection shall be not less than 90 % of the diameter of hole previously measured.

When it is necessary to make the boundary of plating clear, etching shall be carried out after the polishing.

- (4) Test In the test, examine the items specified in the detail specification with a microscope of the specified magnification.

6.3 Dimensions test

6.3.1 Outline dimensions

- (1) Equipment The equipment shall be the vernier calliper specified in JIS B 7507 or an equipment at least equivalent in accuracy.
- (2) Measurement Measure the length and width to the nearest 0.05 mm.

6.3.2 Thickness

- (1) Equipment The equipment shall be the micrometer calliper for external measurement specified in JIS B 7502 or an equipment at least equivalent in accuracy.
- (2) Measurement Measure the thickness or total thickness of the specimens to the nearest 0.01 mm.

6.3.3 Diameter of hole

- (1) Equipment The equipment shall be a magnifier equipped with reading scale with an accuracy of 0.01 mm or better, or an equipment at least equivalent in accuracy.
- (2) Measurement Measure the diameters of the specified holes.

6.3.4 Position of hole

- (1) Equipment The equipment shall be a coordinate measuring apparatus or a measuring microscope with an accuracy of 0.01 mm or better, or an equipment at least equivalent in accuracy.

(2) Measurement

- (a) In case of measuring relative position of a hole to the fundamental lattice, hold the specimen by means of a suitable method, and measure the distance from the reference hole or reference point on the fundamental lattice of the specimen to the hole to be measured along the X axis and Y axis.
- (b) In case of measuring a position of hole from an optional hole, hold the specimen by means of a suitable method, and measure the distance from the said optional hole to the hole to be measured.

6.3.5 Width and minimum spacing of conductor

- (1) Equipment The equipment shall be a reading microscope with an accuracy of 0.01 mm or better, or an equipment at least equivalent in accuracy.
- (2) Measurement Hold the specimen by means of a suitable method, and measure the width of conductor and the minimum spacing between conductors.

6.3.6 Lacking conductor and residual conductor

- (1) Equipment The equipment shall follow 6.3.3 (1) or 6.3.4 (1).
- (2) Measurement Measure the dimensions of lacking conductor on the conductor part and the dimensions of residual conductor on the insulation part, along the longitudinal direction and lateral direction of the conductor.

6.3.7 Diameter of land

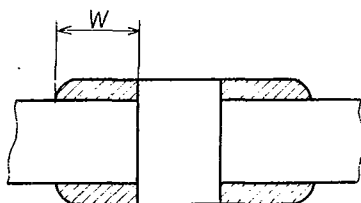
- (1) Equipment The equipment shall follow 6.3.4 (1).
- (2) Measurement Measure the maximum dimensions of land observed from the right above.

6.3.8 Width of land

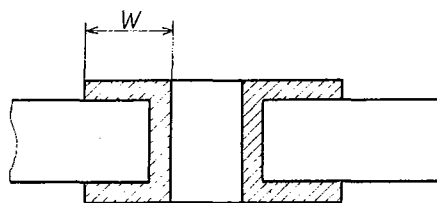
- (1) Equipment The equipment shall follow 6.3.4 (1).
- (2) Measurement Measure the dimension (W) between the edge of land conductor and inner wall of the hole illustrated in Fig. 1.

Fig. 1. Width of land

(a) Hole without plating



(b) Hole with plating



6.3.9 Flatness(1) Warp

- (a) Equipment The equipment shall be the height gauge specified in JIS B 7517 or an equipment at least equivalent in accuracy.
- (b) Measurement As shown in Fig. 2, place the printed board on the precision surface plate specified in JIS B 7513 with the convex upwards, measure the maximum clearance between the surface plate and the surface of specimen to the nearest 0.1 mm, and take this measured value as the warp (h_w).

Fig. 2. Warp

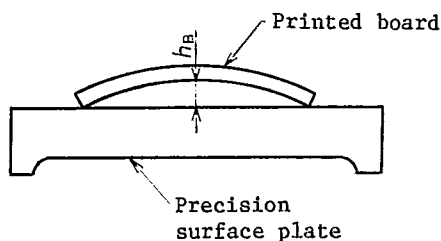
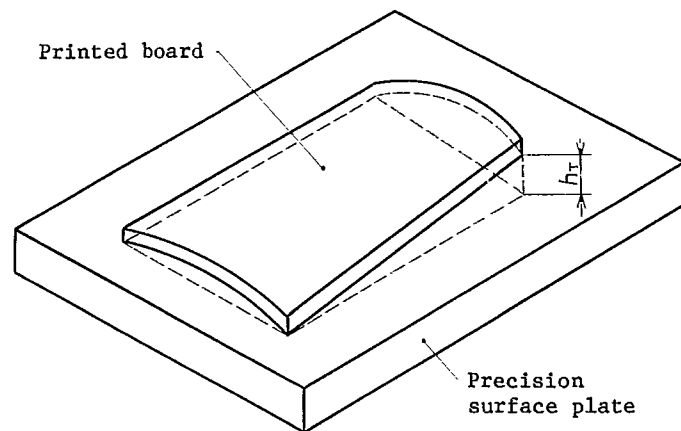


Fig. 3. Twist

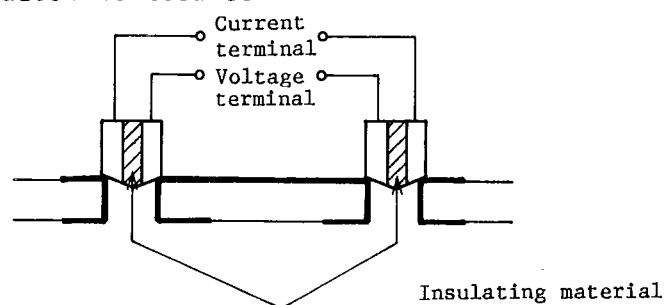
(2) Twist

- (a) Equipment The equipment shall be the feeler gauge specified in JIS B 7524, the height gauge specified in JIS B 7517, or an equipment at least equivalent in accuracy.
- (b) Measurement As shown in Fig. 3, place the printed board on the precision surface plate specified in JIS B 7513 with the convex upward so that three points out of four corners are in contact with the surface plate, measure the clearance between the surface plate and the other one point separating from the surface plate to the nearest 0.1 mm, and take this measured value as the twist (h_r).

7. Electrical performance tests7.1 Resistance of conductors7.1.1 Conductor

- (1) Equipment The equipment shall be that employing voltage drop method (four-terminal method) or that at least equivalent. The current to be passed shall be d.c. current.
- (2) Specimen The specimen shall be a conductor as long and narrow as possible, and shall comply with the detail specification.
- (3) Preconditioning The preconditioning shall be as specified in 5.
- (4) Test Take care to avoid the influences due to contacting method of probe and due to heat generation by measuring current, and measure the resistance value within an accuracy $\pm 5\%$ by the method shown in Fig. 4. using the equipment of (1).

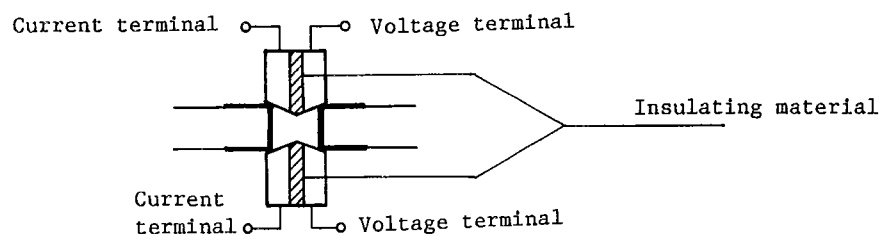
Fig. 4. Contacting method of electrodes for measurement of conductor resistance



7.1.2 Plated through hole

- (1) Equipment The equipment shall be as specified in 7.1.1 (1).
- (2) Specimen The specimen shall be the specified parts of printed board or test coupon or the specified part of composite test pattern (example: D of each Attached Figure).
- (3) Preconditioning The preconditioning shall be as specified in 5.
- (4) Test Take care to avoid the influences due to contacting method of probe and due to heat generation by measuring current, and measure the resistance value within an accuracy $\pm 5\%$ by the method shown in Fig. 5.

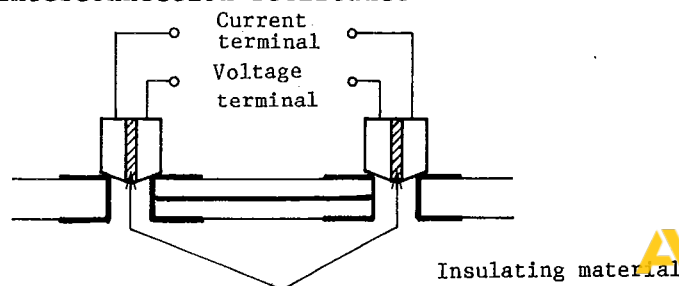
Fig. 5. Contacting method of electrodes for measurement of plated through hole resistance



7.1.3 Interconnection

- (1) Equipment The equipment shall be as specified in 7.1.1 (1).
- (2) Specimen The specimen shall be the specified parts of printed board or test coupon or the specified part of composite test pattern (example: L of each Attached Figure).
- (3) Preconditioning The preconditioning shall be as specified in 5.
- (4) Test Take care to avoid the influences due to contacting method of probe and due to heat generation by measuring current, and measure the resistance value within an accuracy $\pm 5\%$ by the method shown in Fig. 6.

Fig. 6. Contacting method of electrodes for measurement of interconnection resistance



7.2 Current proof of conductor (when specified in the detail specification)

7.2.1 Equipment The equipment shall be a d.c. or a.c. power supply which can pass the test current of 7.2.4, an ammeter and a temperature measuring device.

7.2.2 Specimen The specimen shall be the specified part of conductor in printed board, composite test pattern (to be selected referring to Attached Fig. 3).

7.2.3 Preconditioning The preconditioning shall be as specified in 5.

7.2.4 Test Pass the a.c. or d.c. current specified in the detail specification for the specified duration through the specified conductor and then measure the temperature rise (refer to Attached Fig. 3 for the current).

Carry out this test only when the current-proof characteristic is necessary.

7.3 Current proof of plated through hole

7.3.1 Equipment The equipment shall be a d.c. or a.c. power supply which can pass the test current of 7.3.4 and an ammeter.

7.3.2 Specimen The specimen shall be the plated through holes of printed board, test coupon or composite test pattern.

7.3.3 Preconditioning The preconditioning shall be as specified in 5.

7.3.4 Test Pass the test current specified in the detail specification to the plated through holes of specimen continuously for 30 s, and examine existence or nonexistence of any abnormality during that period.

An example of the test current versus the diameter of hole is shown in Table 1.

Table 1. Example of test current versus hole diameter

Diameter of hole	mm	0.6	0.8	1.0	1.3	1.6	2.0
Test current	A	8	9	11	14	16	20

Carry out this test only when the current-proof characteristic is especially necessary.

7.4 Voltage proof of surface layers

7.4.1 Equipment The equipment shall be the circuit breaker specified in 6.2 (Circuit breaker) of JIS C 2110, or at least the equivalent.

7.4.2 Specimen The specimen shall be the specified part of printed board, composite test pattern, etc. (example: E of Attached Figs. 1 and 2).

The specimen which causes mechanical damage, flash over, spark over or dielectric breakdown in this test shall not be used for other tests.

7.4.3 Preconditioning The preconditioning shall be as specified in 5.

7.4.4 Test Apply the voltage specified in the detail specification as a d.c. voltage or a peak voltage of substantially sinusoidal a.c. voltage at a frequency 50 Hz or 60 Hz, to the specified part of printed board. Raise the applied voltage gradually to the specified voltage in about 5 s, maintain the voltage for 1 min, and then examine existence or nonexistence of such abnormalities as mechanical damage, flash over, spark over and dielectric breakdown.

7.5 Voltage proof between layers

7.5.1 Equipment The equipment shall be as specified in 7.4.1.

7.5.2 Specimen The specimen shall be the specified part of printed board, composite test pattern, etc. (example: M of Attached Fig. 2.1).

The specimen which causes mechanical damage or dielectric breakdown shall not be used for other tests.

7.5.3 Preconditioning The preconditioning shall be as specified in 5.

7.5.4 Test Carry out the test as specified in 7.4.4.

7.6 Insulation resistance of surface layers

7.6.1 Equipment The equipment shall be the high insulation resistance meter specified in JIS C 1303, or a standard resistance, a universal shunt and a galvanometer calibrated to an accuracy of $\pm 10\%$.

7.6.2 Specimen The specimen shall be the specified part of printed board, test coupon, composite test pattern, etc. (example: E of Attached Figs. 1 and 2).

7.6.3 Preconditioning The preconditioning shall be as specified in 5.

7.6.4 Test Apply any one of d.c. voltages 10 ± 1 V, 100 ± 15 V or 500 ± 50 V, as specified in the detail specification, for 1 min, then measure the insulation resistance with the said voltage applied.

7.7 Insulation resistance of internal layers

7.7.1 Equipment The equipment shall be as specified in 7.6.1.

7.7.2 Specimen The specimen shall be the specified part of printed board, test coupon, composite test pattern, etc. (example: J of Attached Fig. 2.1).

7.7.3 Preconditioning The preconditioning shall be as specified in 5.

7.7.4 Test Carry out the test as specified in 7.6.4.

7.8 Insulation resistance between layers

7.8.1 Equipment The equipment shall be as specified in 7.6.1.

7.8.2 Specimen The specimen shall be the specified part of printed board, test coupon, composite test pattern, etc. (example: M of Attached Fig. 2.1).

7.8.3 Preconditioning The preconditioning shall be as specified in 5.

7.8.4 Test Carry out the test as specified in 7.6.4.

7.9 Electrical integrity

7.9.1 Test for circuit isolation

- (1) Equipment The equipment shall consist of a voltage supply which can apply the test voltage, resistance measuring apparatus and probes to have electrical connection with the specified positions on the conductor pattern.

The power supply shall allow current observation and shall have a function to limit the current.

- (2) Specimen The specimen shall be the specified part of the product or the test coupon.
- (3) Preconditioning The preconditioning shall be as specified in 5.
- (4) Test Verify the absence of conductive connection between specified parts of a conductive pattern of a printed board that were intended to be unconnected, in accordance with the relevant specification (i.e., artwork, computer aided test data, detail specification, etc.).

Apply the test voltage specified in the detail specification across the specified positions of the conductor pattern to be tested and obtain the resistance from the current passes through the conductors. If the measured resistance is not less than the minimum specified value, consider that isolation of the circuit is maintained.

The test voltage, duration of voltage application and permissible minimum resistance value shall be as specified in the detail specification.

7.9.2 Test for circuit continuity

- (1) Equipment The equipment shall consist of a current supply which can supply the test current, resistance measuring apparatus, and probes to have electrical connection with the specified positions on the conductor pattern.
- (2) Specimen The specimen shall be the specified part of the product.
- (3) Preconditioning The preconditioning shall be as specified in 5.

- (4) Test Verify the establishment of electrical continuity through the specified connected points of a conductive pattern, in accordance with the relevant specification (i.e. artwork, computer aided test data, detail specification, etc.).

Pass the test current specified in the detail specification through the specified positions on the conductive pattern to be tested and obtain the resistance from the voltage difference between the said two points. If the measured resistance does not exceed the maximum specified value, consider that continuity of the circuit is maintained.

The test current, duration of current and permissible maximum resistance value shall be as specified in the detail specification.

8. Mechanical performance tests

8.1 Peel strength of conductor

8.1.1 Equipment The equipment shall be a tension tester which can maintain the cross head speed at 50 mm/min. Provided that, the error is within $\pm 1\%$ of the indicated value at a scale throughout the effective measuring range, and the load at peeling-off corresponds to 15 % to 85 % of the capacity.

Further, a metal support which can maintain the angle of peeling direction to the adhesive surface at 90° shall be used, during the peeling of conductor from the insulation board.

8.1.2 Specimen The specimen shall be a printed board having straight conductors of suitable length and uniform width (example: G of Attached Figs. 1 and 2).

The board with a conductor width less than 0.8 mm shall not be used.

8.1.3 Preconditioning The preconditioning shall be as specified in 5.

8.1.4 Test Carry out the test under standard conditions for testing as follows:

Detach the conductor of specimen from the insulation board for a distance of about 10 mm at one end, mount the specimen onto the said metal support, grip the detached end of conductor with the clamp, then peel the conductor in the direction perpendicular to the surface of the specimen for a distance of at least 25 mm, at a speed of 50 mm/min. Take the minimum value of the load per unit width (N/mm) appeared during this procedure as the peel strength.

Carry out retest if the conductor breaks within 25 mm.

8.2 Pull-out strength of land with plain hole

8.2.1 Equipment The equipment shall be as specified in 8.1.1 and 10.3.1.

8.2.2 Specimen The specimen shall be isolated circular lands (example: J of Attached Fig. 1), and the land, hole and lead wire dimensions given in Table 2 are used as the standard. The wires and lands are preliminarily soldered within 3 s, using the solder specified in 10.3.2 and suitable flux by means of the equipment of 10.3.1. If other dimensions are used, they shall be specified in the detail specification.

Table 2. Land, hole and wire dimensions

Unit: mm

Land diameter	Hole diameter	Wire diameter
4	1.3	0.9 to 1.0
2	0.8	0.6 to 0.7

8.2.3 Preconditioning The preconditioning shall be as specified in 5.

8.2.4 Test

- (1) Insert a lead wire through the hole of specimen so that it projects a short length from the rear surface without bending, and solder it to the land on the front surface. Carry out the soldering using a soldering iron (with tip diameter 5 ± 0.1 mm) at a bit temperature of $270 \pm 10^\circ\text{C}$ within 3 s to 5 s, without making the iron in direct contact with the land. After the soldering, allow the specimen to stand at room temperature for at least 30 min for cooling. Then pull the lead wire by means of the tensile tester at a speed of 50 mm/min in a direction perpendicular to the specimen, and measure the load when the land separates from the insulating board.

Do not consider the break or coming-out of wire as a defect, and carry out the retest.

- (2) When pull-out strength of land which was repeatedly soldered is measured, remove the wire from the specimen prepared by the procedures of (1) in the same way, and solder the new wire to the same land under the same conditions as those stated in (1).

Repeat this removal and re-soldering of wire for the number of times specified in the detail specification (provided cool the specimen every time) then allow the specimen to stand at room temperature for at least 30 min for cooling. Then pull the wire by means of the tensile tester at a speed of 50 mm/min in a direction perpendicular to the specimen and measure the load when the land separates from the insulating board.

Do not consider the break or coming-out of wire as a defect, and carry out the retest.

8.3 Pull-out strength of plated through hole

8.3.1 Equipment The equipment shall be as specified in 8.1.1.