IEC 61189-5-503

Edition 1.0 2017-05

INTERNATIONAL STANDARD

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Test methods for electrical materials, printed board and other interconnection structures and assemblies –
Part 5-503: General test method for materials and assemblies – Conductive anodic filaments (CAF) testing of circuit boards

IEC 61189-5-503:2017-05(en)

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COMMISSION

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TEST METHODS FOR ELECTRICAL MATERIALS, PRINTED BOARD AND OTHER INTERCONNECTION STRUCTURES AND ASSEMBLIES –

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FOREWORD

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International Standard IEC 61189-5-503 been prepared by IEC technical committee 91: Electronics assembly technology.

The text of this standard is based on the following documents:

FDIS	Report on voting
91/1433/FDIS	91/1443/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61189 series, published under the general title *Test methods for electrical materials, printed boards and other interconnection structures and assemblies*, can be found on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

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TEST METHODS FOR ELECTRICAL MATERIALS, PRINTED BOARD AND OTHER INTERCONNECTION STRUCTURES AND ASSEMBLIES –

Part 5-503: General test method for materials and assemblies – Conductive anodic filaments (CAF) testing of circuit boards

1 Scope

This part of IEC 61189 specifies the conductive anodic filament (hereafter referred to as CAF) and specifies not only the steady-state temperature and humidity test, but also a temperature-humidity cyclic test and an unsaturated pressurized vapour test (HAST).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

IEC 60068-2-38, *Environmental testing – Part 2-38: Tests – Test Z/AD: Composite temperature/humidity cyclic test*

IEC 60068-2-66, *Environmental testing – Part 2: Test methods – Test Cx: Damp heat, steady state (unsaturated pressurized vapour)*

IEC 60068-2-67, *Environmental testing – Part 2: Tests – Test Cy: Damp heat, steady state, accelerated test primarily intended for components*

IEC 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60194, *Printed board design, manufacture and assembly – Terms and definitions*

IPC-TM-650 No.2.6.14.1, *Electrochemical Migration Resistance Test [viewed 2017-01-31]. Available at: https://www.ipc.org/TM/2-6_2-6-14-1.pdf*

IPC-TM-650 No.2.6.25, *Conductive Anodic Filament (CAF) Resistance Test: X-Y Axis [viewed 2017-01-31]. Available at: https://www.ipc.org/4.0_Knowledge/4.1_Standards/test/2-6-25.pdf*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60194 and IEC 60068-1 as well as the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
electrochemical migration
degradation of insulation characteristics between conductors due to eletrochemical elution of ions in a humid environment when voltage is applied to conductors of a printed wiring board

Note 1 to entry: In addition, ionic impurities present in the insulations contribute to their degradation.

Note 2 to entry: Electrochemical migration may take the forms of dendrite (3.2) and CAF(3.3).

3.2
dendrite
metal migration

Note 1 to entry: Dendrite is visible in that it creates a branching and tree like structure on the surface, on the interface between layers, etc. of a printed wiring board.

3.3
CAF
conductive anodic filament
migration which occurs along the monofilament of reinforcing material such as glass cloth in an inner layer part of a printed wiring board

3.4
HAST
highly accelerated temperature and humidity stress test
stress test under unsaturated pressurized vapour test

Note 1 to entry: See IEC 60068-2-66.

3.5
automatic insulation resistance measurement
measurement to take continuous or predetermined periodic test data using an automatic measurement system without an operator

3.6
manual insulation resistance measurement
measurement to take predetermined periodic test data using measurement equipment by an operator

Note 1 to entry: Measurement can be done with or without taking out a specimen from the test chamber.

3.7
test voltage
voltage to apply on the specimen as a stress in the testing environment

3.8
measuring voltage
voltage to apply on the specimen in order to measure the insulation resistance

4 Testing condition

4.1 Standard condition

Measurement is performed under the standard atmospheric condition which is specified in Clause 4 of IEC 60068-1:2013.

It depends on a reference condition stated in 4.2 when an ambiguity is found for the judgment in the standard atmospheric condition or when it is required in particular.

It may be performed under other conditions than the standard atmospheric condition, when no doubt about the judgment subsits and when measuring in standard condition proves difficult, or when specified in particular specifications.

4.2 Judgment state

Reference condition is the standard atmospheric condition for measurement as stated in 4.2 of IEC 60068-1:2013.

5 Specimen

5.1 Outline of CAF test vehicle design

5.1.1 Evaluation design for the glass cloth direction

The in-line test combs are comprised of a series of alternate rows of via holes with a voltage applied across the comb. They represent the most common failure sites where CAF can occur: between via hole walls. The via holes are in line with one another and in alignment with the woven glass fibre reinforcement. The closest point between each via pair is the most likely point for CAF growth (example highlighted in Figure 1). The black spots represent the drilled hole, and the copper pads associated with the via holes are in orange.

The construction of staggered combs is similar to that of the in-line combs, however, the via pairs are arranged at 45°. This means that the most likely route for potential CAF growth is longer since the orientation of the glass fibres may only permit growth in the horizontal and vertical directions (as represented by the white ellipses in Figure 2).

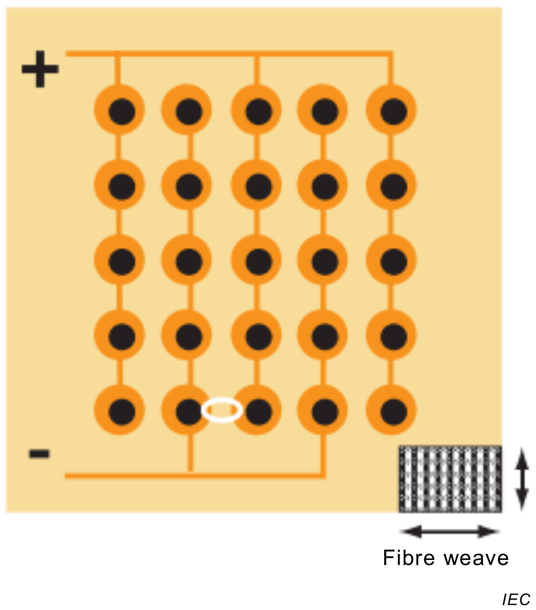


Figure 1 – Schematic of in-line test comb, with possible failure site

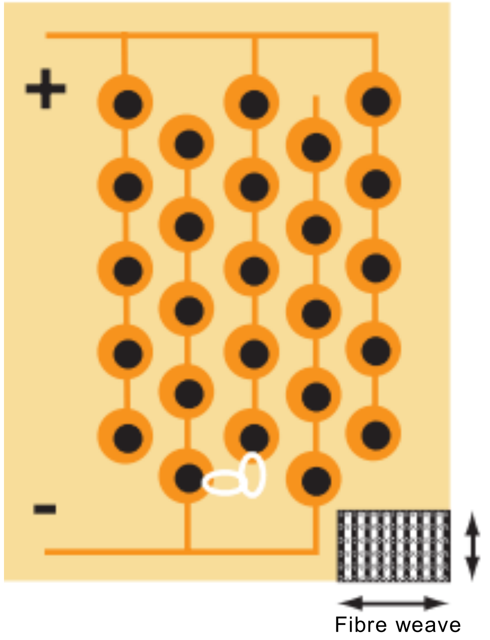


Figure 2 – Schematic of staggered test comb, with possible failure site

"Manhattan distance" is the shortest orthogonal distance along the X- and/or Y- axes lines between adjacent drilled hole features (corresponds to the orthogonal nature of the laminate material's woven glass fibre reinforcement (Figure 3).

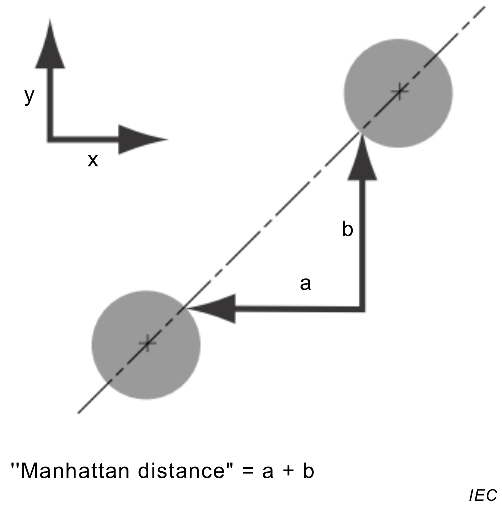


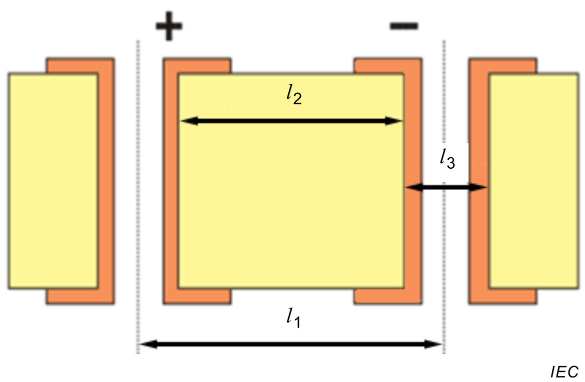
Figure 3 – Manhattan distance

5.1.2 Design between plated through hole (PTH)

a) Without inner layer pattern

Example design between PTH without inner layer pattern is shown in Figure 4, which is a schematic cross-section of a via pair.

NOTE The gap is taken from the edge of the copper. Copper thickness on the hole wall is approximately 50 µm per side.



Key

l_1 via pitch

l_2 via to via distance

l_3 via diameter

Figure 4 – Schematic section of via pair with bias

b) With inner layer pattern

There are two designs. One is the design of inner layer via pads and layers as shown in Figure 5. The other is the design of no inner layer via pads and layer patterns as shown in Figure 6.

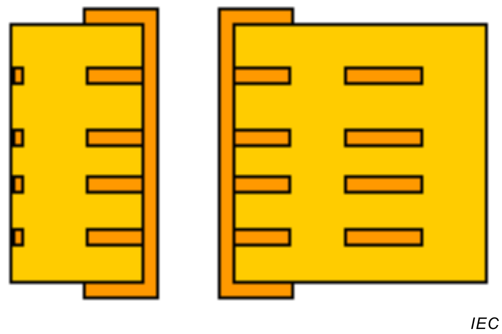


Figure 5 – Example of inner layer via pads and layer patterns

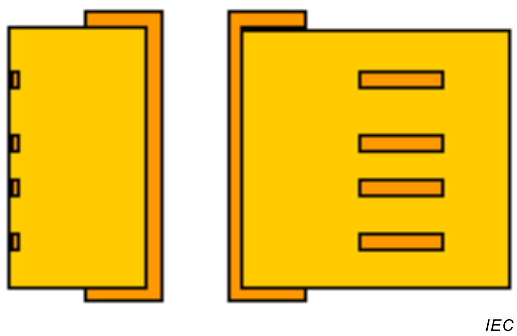
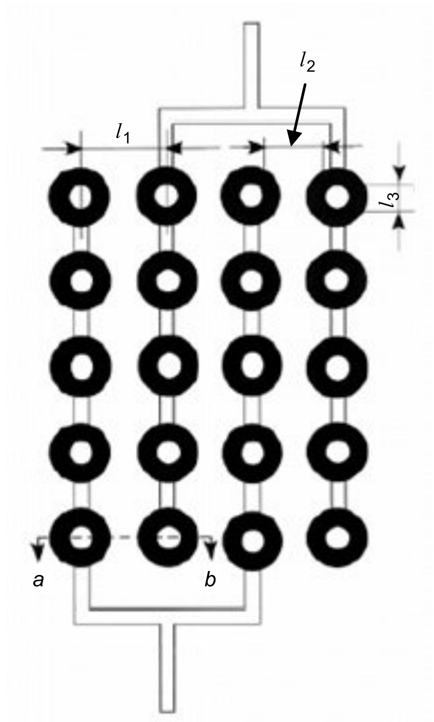


Figure 6 – Example of no inner layer via pads and layer patterns

5.2 CAF test board

5.2.1 Example A

This design is based on 5.1. Evaluation of insulation between through-holes is made using the lattice-like pattern of through-holes as illustrated in Figure 7. The diameter of holes is kept constant. Dimensions of the holes are specified in Table 1. There should be more than five holes on a line in the pattern. The number depends on an agreement between the user and supplier concerned.



Key

l_1 via pitch

l_2 via to Via distance

l_3 via diameter

a and *b* cross-section

Figure 7 – Insulation evaluation pattern for through-holes and via holes

Table 1 – Dimension of insulation evaluation pattern for through-holes

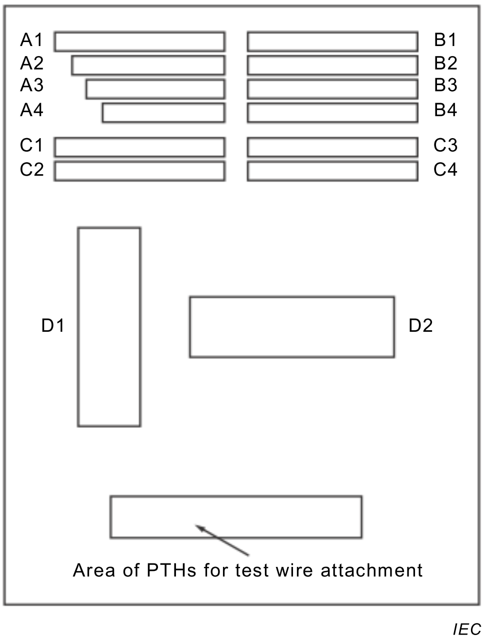
Via diameter (l_3) (µm)	300					
Via to via distance (l_2) (µm)	150	200	250	300	350	400
Via pitch (l_1) (µm)	450	500	550	600	650	700
Pattern arrangement	*n* holes × 4 rows (*n*: ≥ 5)					

5.2.2 Example B

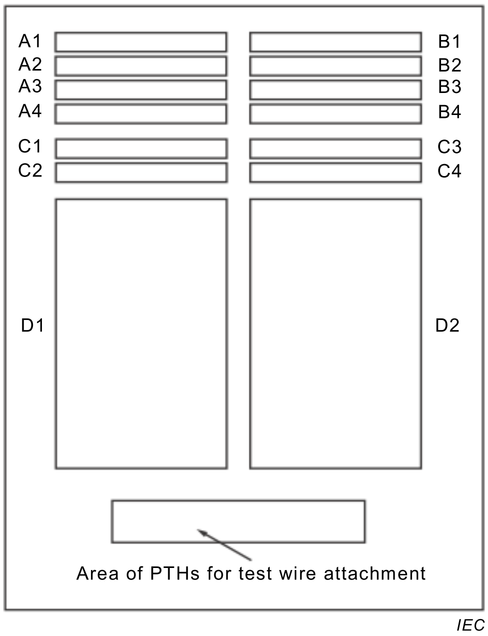
The IPC-9253 and IPC-9254 have 10 layers, and dimensions are approximately 125 mm × 175 mm. Test board designs for evaluating CAF resistance shall have varying drilled hole wall to drilled hole wall distances for plated holes. These distances can range from as low as 0,15 mm separation for alternate laminate materials expected to have very high CAF resistance and minimal copper wicking out from the plated-through hole (PTH), to as high as 0,89 mm separation for evaluating press-fit connector applications. The drilled hole size, rather than the finished hole size, is specified in the chart on the bare board fabrication drawing to ensure consistent spacing.

Internal layer thieving may be added to plane layers around the perimeter. Test boards should be manufactured so that the machine/grain direction of the woven fibre reinforcement is perpendicular to the rows of same-net daisy chain vias for A1 to A4 (machine/grain direction tends to fail first).

Test board designs shall have sufficient minimum spacings on outer layers to ensure that surface insulation resistance failures do not occur. Layouts of the IPC-9253 and IPC-9254 test board structures (CAF test boards) are shown in Figure 8. The test board design rules are listed in Table 2 and Table 3.



a) IPC-9253



b) IPC-9254

Figure 8 – Layouts of the two versions of the CAF test boards

Table 2 – Test structures A1 through A4 design rules

	A1	**A2**	**A3**	**A4**
Outer layer pad size	0,86 mm (0,033 9 in)	0,81 mm (0,031 9 in)	0,75 mm (0,029 5 in)	0,69 mm (0,027 2 in)
Inner layer pad size	0,86 mm (0,033 9 in)	0,81 mm (0,031 9 in)	0,75 mm (0,029 5 in)	0,69 mm (0,027 2 in)
Drilled hole size	0,74 mm (0,029 1 in)	0,63 mm (0,024 8 in)	0,51 mm (0,020 1 in)	0,37 mm (0,025 6 in)
Via edge to via edge (shortest distance)	0,27 mm (0,010 6 in)	0,38 mm (0,015 0 in)	0,51 mm(0,020 1 in)	0,65 mm (0,025 6 in)
Via edge to via edge (Manhattan distance)	0,27 mm (0,010 6 in)	0,38 mm (0,015 0 in)	0,51 mm (0,020 1 in)	0,65 mm (0,025 6 in)
On IPC-9254 only, bias applied between:	J1, J5	J2, J5	J3, J5	J4, J5

Table 3 – Test structures B1 through B4 design rules

	B1	B2	B3	B4
Outer layer pad size	0,94 mm (0,037 0 in)	0,89 mm (0,035 0 in)	0,84 mm (0,033 0 in)	0,75 mm (0,030 0 in)
Inner layer pad size	0,94 mm (0,037 0 in)	0,89 mm (0,035 0 in)	0,84 mm (0,033 1 in)	0,75 mm (0,029 5 in)
Drilled hole size	0,81 mm (0,031 9 in)	0,71 mm (0,028 0 in)	0,57 mm (0,022 4 in)	0,46 mm (0,018 1 in)
Via edge to via edge (shortest distance)	0,26 mm (0,010 2 in)	0,37 mm (0,014 6 in)	0,51 mm(0,020 1 in)	0,62 mm (0,024 4 in)
Via edge to via edge (Manhattan Distance)	0,37 mm (0,014 6 in)	0,52 mm (0,020 5 in)	0,72 mm (0,028 3 in)	0,88 mm (0,034 6 in)
On IPC-9254 only, bias applied between:	J7, J11	J8, J11	J9, J11	J10, J11

5.3 Number of specimens

Number of specimens, test boards or coupons required in a test depends on the purpose of the test, for example for prototypes or for mass produced products. For CAF testing of circuit boards for mass production, a minimum quantity of 25 is needed for statistical reliability analysis. More than 25 specimens may be needed for a test lot in order to provide at least as many opportunities-for-failure as a single production board (see IPC-9691B).

6 Equipment/Apparatus or material

6.1 Environmental test chamber

a) A clean test chamber capable of producing and recording an environment of 65 °C ± 2 °C or 85 °C ± 2 °C at 87 °C ± 2 % RH, and that is equipped with cable access to facilitate measurement cables to be attached to the specimens under test.

b) The temperature and humidity in the chamber can be continuously supplied and not reused, and independently controlled to prevent condensation.

c) Humidification water in the chamber can be continuously supplied and not reused.

d) The condensation water does not drop from the wall and the ceiling in the chamber.

e) Impurities and the residual substances of the previous test shall be removed so as to not affect the test.

f) The chamber should be made of the materials which do not have any influence on the specimen and humidification water.

6.2 Measuring equipment

A high resistance meter equivalent to that described in ASTM D257, with a range up to $10^{12}\ \Omega$ and capable of yielding an accuracy of ±5 % at $10^{10}\ \Omega$ with a DC applied voltage of 100 V ± 2 V, or an ammeter capable of reading 10^{-10} A and capable of yielding an accuracy of ±5 % in combination with 100 V ± 2 V DC power supply. The values of resistors used shall be verified by reference resistors traceable to known industry or national standards.

6.3 Power supply

A power supply capable of producing a standing bias potential of 5 V DC up to 100 V DC with a ±2 % tolerance, and current supply capacity of at least 1 A.

6.4 Current limiting resistors

Tight control of the total current limiting resistance value is critical for this test method. 1 MΩ resistor in series shall be used for each current path. Insert the current limiting resistors in series with the terminating leads going to each test pattern. Note that some test equipment has current limiting resistors built into the testing systems. For the purposes of this standard test, excluding the current limiting resistor and for each CAF test circuit, the total series resistance of the measuring equipment and wires shall not be more than 200 Ω. A lower total resistance value will increase potential for damage to the test board when a CAF failure occurs. A higher total current limiting resistance value for each test net removes test conditions further from actual field conditions and is not recommended.

6.5 Connecting wire

Use PTFE- or PFE-insulated copper wires and solder the copper wire directly to the board to connect test points for each test board to the measurement apparatus.

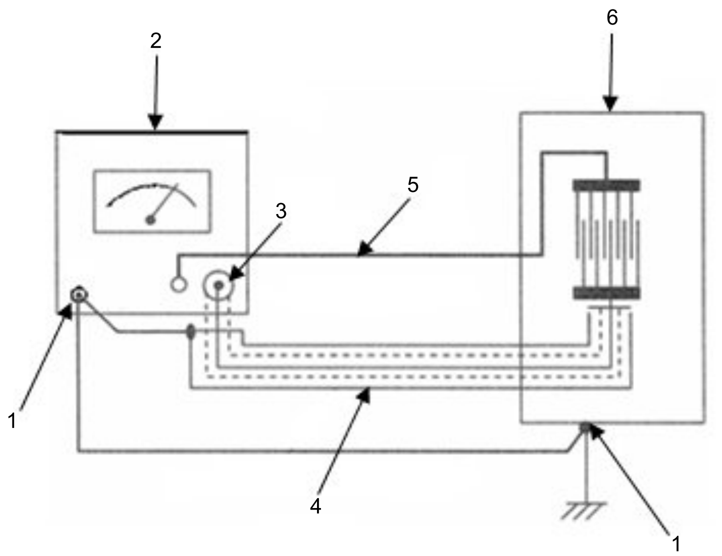
6.6 Other dedicated fixtures

Hard-wiring is the default connection method. Other dedicated fixtures may be used, provided that the fixture does not change the resistance by more than 0,1 decade compared to a comparable hard-wired system when measured at the test conditions. These fixtures should be checked for their resistance values frequently. The colour of the leads connected to plus and minus electrodes of the measuring equipment should be changed. Usually red is used for the cable connected to the plus terminal and black to the minus terminal.

7 Resistance measurement method

7.1 Manual insulation resistance measurement method

The resistance measuring unit can measure the resistance range of $10^6\,\Omega$ to $10^{12}\,\Omega$. Figure 9 illustrates an example of a manual measuring system in the chamber, using an insulation resistance meter. This measuring system has a built-in power source, can select the test voltage and the measuring voltage arbitrary, and is capable of resistance measurement of up to $10^{13}\,\Omega$ using double shielded cables and a shielded test chamber.



Key

1 guard

2 insulation resistance meter

3 active guard

4 double shield cable

5 power supply

6 chamber

Figure 9 – Measurement with insulation resistance meter

7.2 Automatic insulation resistance measurement method

The insulation resistance generally decreases as temperature and relative humidity increase. The volume resistance is sensitive to the change of the temperature, but the surface resistance changes rapidly with the change of the relative humidity. As for both cases, the change is exponential. Since insulation resistance is dependent on both volume resistance and surface resistance, it is necessary to hold temperature and humidity to the specified values as much as possible. For this reason, it is desirable to perform the measurement of insulation resistance within the chamber (measurement in the chamber). In taking out the specimen from the chamber to measure, the time to shift to room temperature (measurement conditions) and leaving time in the room temperature should be decided. In principle, this measurement shall be made within 24 h. The condition other than stated here should be provided in an individual specification.

The automatic insulation resistance equipment can control automatically the applied voltage and measurement by a computer, and generate an alarm when anomaly is generated in the measurement without taking out the specimen under test from the test chamber. The test voltage is applied to each specimen and leak electric current is monitored so that the generation and time of electrochemical migration can be measured precisely. Tests of many specimens can be carried out efficiently.

A test should be continued when such phenomena as a momentary low resistance state or a temporary short in the measurement using an automatic insulation resistance measurement equipment do not occur frequently.

8 Test method

8.1 Test method selection

The ECM test method is used as a lifetime evaluation test of substrate materials and electronic parts and acceptance test at the order source. The former is required to obtain the time to failure, which is the standard for calculating the useful life. In the latter, the temperature/humidity condition, the applied voltage, and the test time are determined, and the process is completed in a predetermined time. Selection of the various ECM test methods described here is left to the user.

8.2 Steady-state temperature and humidity test

8.2.1 Object

This test is implemented to ensure or verify the ability to maintain the service life if the specimen is used under constant temperature and humidity conditions. This test is an accelerated test which is set at a higher temperature and humidity than when the specimen is used. It is important that linearity can be achieved for the Arrhenius plot obtained from the fault time to temperature changes to evaluate the lifetime. If the linearity is not obtained, it is necessary to review the test conditions and to pay sufficient attention to high temperature conditions. On the basis of the results of the life test, the test conditions of the confirmation test are determined.

8.2.2 Test condition

The steady-state temperature and humidity test conditions follows in Table 4. These may be used in the absence of any defined test specification. Test condition of temperature/humidity is specified in IEC 60068-2-78 and IEC 60068-2-67 except 60 ºC/90 % RH, which is added as one of the temperature humidity steady-state conditions because it has been used as one of the standard environmental test conditions for the integrated circuits.

Table 4 – Test condition

<table>
<tr><th>Specification</th><th>Temperature
°C</th><th>Humidity
% RH</th><th colspan="4">Test time
h</th></tr>
<tr><td rowspan="3">STD</td><td>40 ± 2</td><td>93 ± 3</td><td rowspan="3">168^{+24}_{-0}</td><td rowspan="3">500 ± 48</td><td rowspan="3">1 000 ± 96</td><td rowspan="3">(2 000 ± 192)</td></tr>
<tr><td>60 ± 2</td><td>90 ± 3</td></tr>
<tr><td>85 ± 2</td><td>85 ± 3</td></tr>
<tr><td rowspan="2">IPC-TM-650
(2.6.25)</td><td>65 ± 2</td><td rowspan="2">87+ 3/−2</td><td colspan="4" rowspan="5">– Test boards to stabilize for 96 h (±30 min).
After the 96 h (±30 min) stabilization period, insulation resistance measurements shall be made between each daisy chain net and ground.
– Additional temperature/humidity/bias conditioning may be performed after 500 h of bias, sometimes up to 1 000 h or more.</td></tr>
<tr><td>85 ± 2</td></tr>
<tr><td rowspan="3">IPC-TM-650
(2.6.14.1)</td><td>40 ± 2</td><td>93 ± 2</td></tr>
<tr><td>65 ± 2</td><td>88,5 ± 3,5</td></tr>
<tr><td>85 ± 2</td><td>88,5 ± 3,5</td></tr>
</table>

8.3 Temperature and humidity (12 h + 12 h) cycle test

8.3.1 Object

This test examines the insulation degradation, resistance to electrochemical migration, and other performance degradations for printed wiring boards under the 12 h + 12 h cyclic damp heat condition with an applied voltage to the specimen in which dew is generated on the surface.

8.3.2 Test condition

The 12 h + 12 h cyclic damp heat test condition is specified in IEC 60068-2-30.

8.3.3 Number of cycles of the test

The combination of the upper temperature and the number of cycles define the severity of the test. The upper temperature and the number of cycles shall be chosen from Table 5.

Table 5 – Number of cycles of the test

Condition	Upper temperature	Number of cycles
a)	40 °C	5, 10, 20, 30, (50)
b)	55 °C	5, 10, 20, (30)
Condition a) or b) shall be selected based on individual specifications.		

8.4 Temperature and humidity cyclic test with and without low temperature exposure

8.4.1 Object

This test evaluates the resistance of the board to electrical insulation degradation and resistance to migration under the temperature and humidity cyclic test with and without low temperature exposure. It is an effective test to confirm the durability of the products in environments with varying temperature and humidity.

8.4.2 Test condition

The test condition for the steady-state temperature and humidity test is given in Table 6 unless there is any additional condition.

Table 6 – Test condition

1)	The test condition of temperature/humidity is specified in IEC 60068-2-38.
2)	Test severities: 10 cycles
3)	Tolerance for temperature: ±2 ºC (in chamber)
4)	Tolerance for relative humidity:
	±3 % RH (during the periods constant or rising temperature)
	80 % to 96 % RH (during the falling temperature)
5)	Test severities (unless ten cycles): depending on individual specification
6)	Measuring time: depending on individual specification
7)	Test voltage: depending on individual specification
8)	Measuring voltage: depending on individual specification.

8.5 Steady-state high temperature and high humidity (unsaturated pressurized vapour) test

8.5.1 Object

This test enables an accelerated evaluation of insulation deterioration of material by forced moisture absorption, resistance to migration, comparison of material characteristics, lot reliability, moisture proof reliability for insulating film (solder resist, etc.) and other performance degradations.

This test enables the evaluation of material characteristics in a short time. It was originally developed to assess semiconductor devices in a package. Note that the relation between the glass transition temperature of an organic resin and the test temperature has an important influence on the estimated lifetime.

If the acceleration factor of lifetime between this test method and the actual operating condition is not clear, this test method is suitable for test comparison purposes, but may not be used as a guarantee for the material.

8.5.2 Test condition

Unless a specific condition is specified, the test condition shall be selected from the conditions given in Table 7, which is specified in IEC 60068-2-66. However, the application of Table 7 depends on individual specifications.

Table 7 – Test condition (IEC 60068-2-66)

Test temperature °C	**Humidity** % RH	**Test time** h		**Vapour pressure** MPa
110 ± 2	85 ± 5	96, 192, 408	–0	0,12
120 ± 2	85 ± 5	48, 96, 192	~	0,17
130 ± 2	85 ± 5	24, 48, 96	+2	0,23

1) The testing time represents the test end time and does not mean the time to extract the test specimen..

2) The testing voltage is selected between 5 V DC and 100 V DC.

3) The measuring voltage is selected between 5 V DC and 100 V DC.

4) Items to be specified by individual specification
   a) Different conditions from this test conditions and severity of the specified condition (mandatory).
   b) Initial measurement (mandatory).
   c) Jig to be used for the test.

9 Procedure

9.1 Test specimen preparation

9.1.1 General

A specimen is inspected using a magnifying glass with a 5 to 10× magnification. Check observable foreign materials, for example extraneous coppers, peeling of solder resist, grimes, and the condition of the surface of metal plating. If any defects are found, the specimen should not be used in the testing.

9.1.2 Sample identification

Use a method to identify each test board which does not cause contamination, such as a scribe and making marks away from the biased area(s) of the specimen. Test boards shall be handled by the edges of the board only, and the use of non-contaminating gloves is recommended.

9.1.3 Prescreen for opens and shorts

Perform as-received insulation resistance measurements using a multimeter by connecting to each net, and check for gross defects. Check for shorts at a 1,0 MΩ setting. No opens are allowed in connected nets.

9.1.4 Cleaning

Clean the specimen with water or alcohol to remove dirt, dust and adhered flux. Set the specimen in the chamber and start the test without handling, packaging or storage which may affect the test result.

9.1.5 Connecting wire

Use PTFE- or PFE-insulated copper wires and solder, and apply the copper wire directly to the board to connect test points for each test board to the measurement apparatus. Cover the test board with non-contaminating film to prevent flux spattering during the wire attach process. Ensure that PWB laminate material adjacent to the plated holes does not get damaged during soldering by using appropriate time/temperature parameters for the soldering iron.

9.1.6 Cleaning after attachment

Perform appropriate local cleaning and rinsing after the attachment of the connecting wires. Isolation resistance between connecting wire attachment sites should remain excellent during 96 h conditioning. Note that each CAF test failure that occurs during subsequent testing should be checked, to determine whether the connecting wire attach area is the low resistance site. If the connecting wire attach area rather than the daisy chain area is the low insulation resistance site, then that test sample is no longer valid for data analysis.

9.1.7 Dry

Bake sample boards for 6 h in a clean oven at (105 ± 2) °C.

9.2 Precondition

Precondition test board samples in a bias-free state (no electrical potential applied to any test pattern) for 24 h minimum at (23 ± 2) °C and (50 ± 5) % relative humidity prior to any initial insulation resistance measurements (measuring insulation resistance of each daisy-chain net on each test board before starting the first 96 h (±30 min) of bias-free temperature and humidity conditioning).

9.3 Test procedure

9.3.1 Setting of the specimen

a) The ventilation direction and a specimen side should be parallel. The specimen may be hung from the ceiling of the chamber or is put up with a test fixture. Specimens should be installed in parallel to the air flow direction wind and be separated 15 mm or more so that the air flow in the chamber may not be disturbed.
b) Avoid cable routing and dips which may allow condensed water to drop on the test specimen.
c) Specimens should not be placed close to the heat source and wall of a chamber. The working space where the specified testing conditions can be controlled within specified tolerance is specified in IEC 60068-3-5.

9.3.2 Test voltage and measuring voltage

a) The recommended voltage range of test and measuring voltage is 5 V DC to 100 V DC. The voltage range exceeding this range may be used depending on individual specification.
b) The test voltage and the measuring voltage shall always have the same polarity, and as a general rule shall be assumed to have the same DC voltage value.
c) For tests of multilayer boards the method to supply test voltage between each layers depends on individual specifications.

9.3.3 Temperature and humidity condition at the start time of the test

a) First the temperature is raised and then the humidity is increased with a suitable time lag, as shown in Figure 10, so as to avoid dew formation on the surfaces of the specimen and the wall in the chamber.

b) The test voltage should be applied as soon as the chamber is in stable condition.

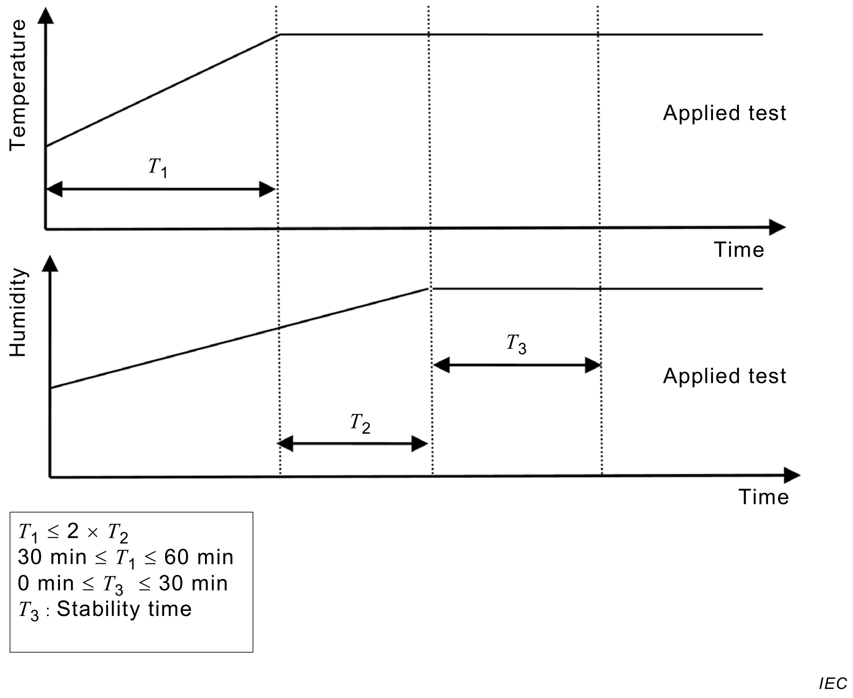


Figure 10 – Temperature and humidity in a test

c) The starting condition of the test is shown in Figure 10 in the case of a steady-state test.

d) The cycle test condition depends on the individual specification.

e) Application of a test condition other than specified here, is described in the individual specification.

9.3.4 Measurement

9.3.4.1 Initial measurement

a) After observing the specimen visually or using a magnifying glass with a 5 to 10× magnification according to 9.4, the measurement of the insulation resistance shall be carried out.

b) The insulation resistance of the test board in standard condition shall be confirmed to be more than 10^{12} Ω, but it should be larger than 10^{10} Ω if phenol resin is used. When the resistance is stated in an individual specification, observe the resistance.

9.3.4.2 Intermediate measurement

Checks shall be carried out to ensure data being measured using automatic insulation resistance measurement equipment. The test may be interrupted and output data should be checked in detail if necessary.

9.3.4.3 Final measurement

The specimen is taken out of the chamber as soon as the temperature in the chamber is back to room temperature at the end of the test.

The visual inspection of a specimen with a magnifying glass with a 5 to 10× magnification is executed according to 9.4.

The insulation resistance measurement is carried out under the standard atmospheric condition according to 4.1.

A fault analysis should be made if necessary. Observe any condition if specified in individual specifications.

9.3.4.4 Evaluation criteria

A failure should be recorded if the resistance becomes less than 10^6 Ω in case of measurement inside of the chamber, or less than 10^7 Ω in case of measurement outside of the chamber.

9.3.5 Procedure in test interruption

a) If the test is interrupted, the specimen is carefully handled to avoid
   1) handling of the specimen with bare hands,
   2) storing in a place which has a large temperature/humidity difference to the test environment, and
   3) adhesion of dirt and dust.
b) During a test interruption the period when the environmental conditions are not stable should not be included in the test time.

9.3.6 End of test

The test is finished after the prescribed examination time.

If test ends with the malfunction of the test equipment or abnormal insulation resistance, this status is recorded clearly in order to obtain any required information for later analysis.

9.4 Visual inspection

9.4.1 General

The inspection process is described below. For effective observations ensure the illumination of the sample allows for viewing of both of reflectance and transmission components of the light.

9.4.2 Shape of electrochemical migration

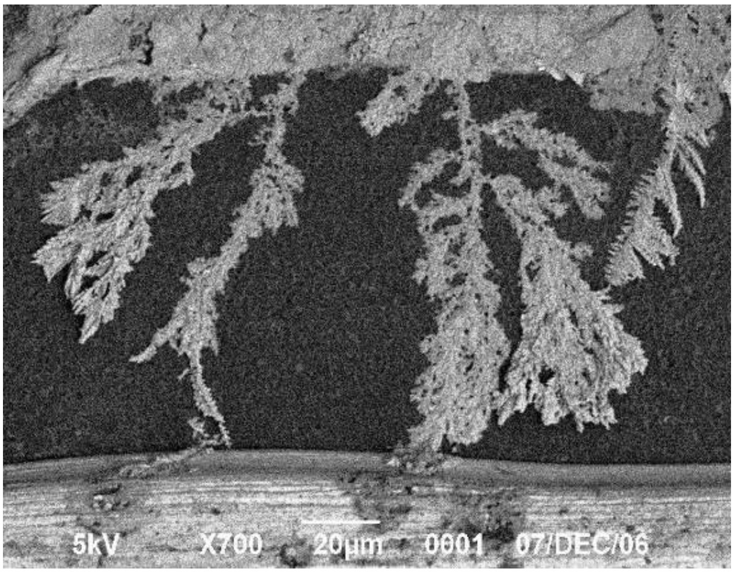
Representative shapes of migration are shown in a) and b) and photographs are also included in Annex A.

a) Shape A (see Figure A.1): The observed example that dendrite-shaped migration occurred on the board surface.
b) Shape B (see Figure A.2): CAF (an example of migration along the glass fibre).

Annex A
(informative)

Forms of electrochemical migration

A.1 Example of dendrite-shaped migration



Specimen: the FPC which did Sn-Pb surface finishing of copper patterns.

Pattern gap is 0,3 mm.

Test condition: water dropped method: 5 V DC applied.

Figure A.1 – Example which is generated on the board surface

A.2 CAF (Example of migration along the glass fibre)

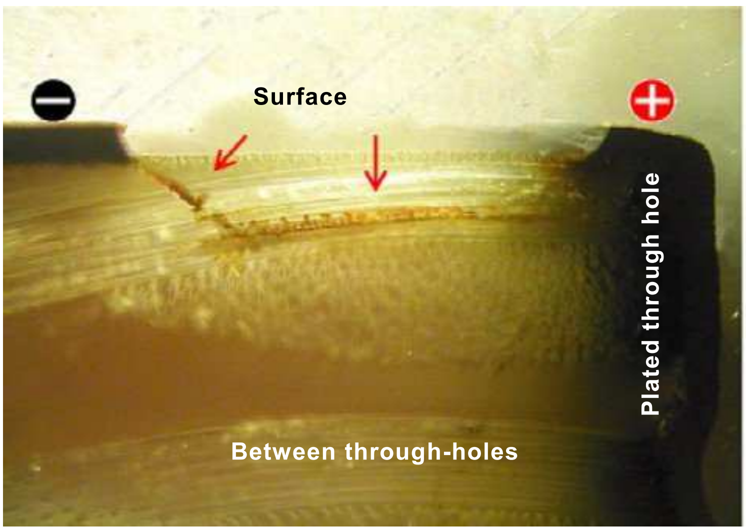


Figure A.2 – Example of CAF

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