# IEC 61189-2-801

Edition 1.0 2023-07

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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## Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 2-801: Thermal conductivity test for base materials

## Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles – Partie 2-801: Essai de conductivité thermique pour matériaux de base



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

## Part 2-801: Thermal conductivity test for base materials

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| Draft | Report on voting |
|---|---|
| 91/1757/CDV | 91/1862/RVC |

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

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

## Part 2-801: Thermal conductivity test for base materials

## 1 Scope

This part of IEC 61189 defines a test method to be followed for thermal performance via carbon ink heating. The method employs a screened-on pattern of carbon ink used to determine the thermal performance of a dielectric layer on a metal base plate.

## 2 Normative references

There are no normative references in this document.

## 3 Terms and definitions

No terms and definitions are listed in this document.



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

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



## 4 Applicability and use of data

This method may be used on any smooth, rigid metal clad laminate providing that the metal base has a thickness of 1,02 mm. The best results are achieved by using a machinable, 1,57 mm thick piece of aluminium alloy. Soft metal or metal with a rough surface is not suitable for this test method.

## 5 Test specimens

### 5.1 Number

Five specimens shall be prepared, unless an alternative number has been specified.

### 5.2 Form

Specimens shall be 25,4 mm × 25,4 mm and have dielectric applied to a single side of the 1,57 mm metal base. Specimens shall include 2 strips of copper that measure 2,5 mm × 20 mm, with a 5 mm spacing between the two. See Figure 1 for the required specimen dimensions.

Dimensions in millimetres

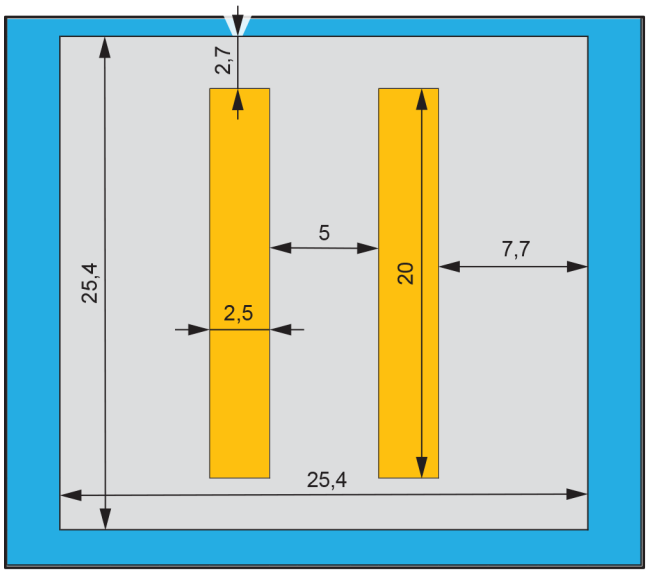


**Figure 1 – Specimen dimensions**

A centralised hole shall be drilled in the 1,57 mm aluminium substrate. The location of the hole shall be such that it is equidistant between the two copper electrodes and terminates at the midpoint, as demonstrated in Figure 2.



Dimensions in millimetres



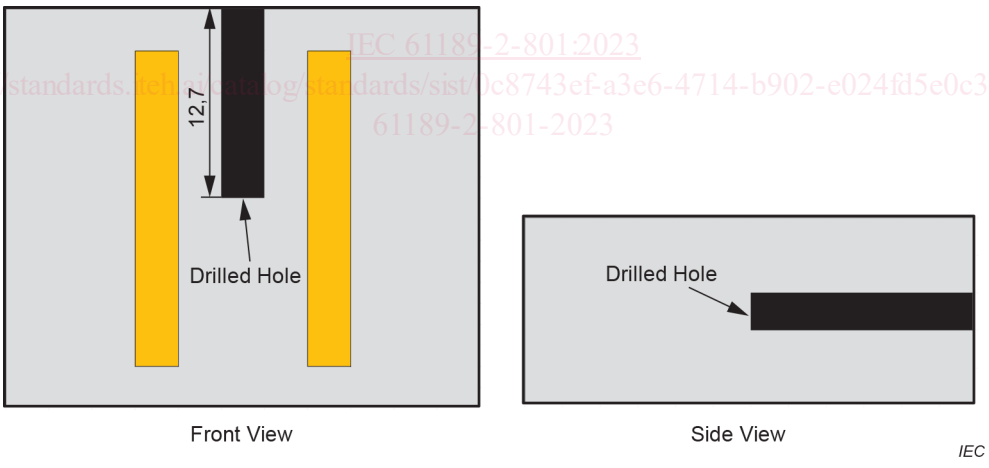


**Figure 2 – Location of 0,55 mm hole**

### 5.3 Preparation of the test specimen

a) Deposit a 12 mm × 5 mm rectangle of carbon ink on the dielectric surface, using a rubber squeegee and a 195-mesh screen that has a 12 mm × 5 mm aperture. See Figure 3 for an example of carbon paste applied to a screen prior to printing.

b) Locate the carbon ink printing such that it is perpendicular to the length of the copper electrodes and is central to the specimen surface.

c) Ensure that the screen and specimen are secured such that there will be no movement during the printing of the carbon ink.

d) For printing the carbon ink, apply the ink to one of the narrow edges of the rectangle and then use the rubber squeegee to spread the paste along the length of the rectangle in the screen, in a single motion. A small amount of downward force should be applied when moving the squeegee from one side of the frame to the other.

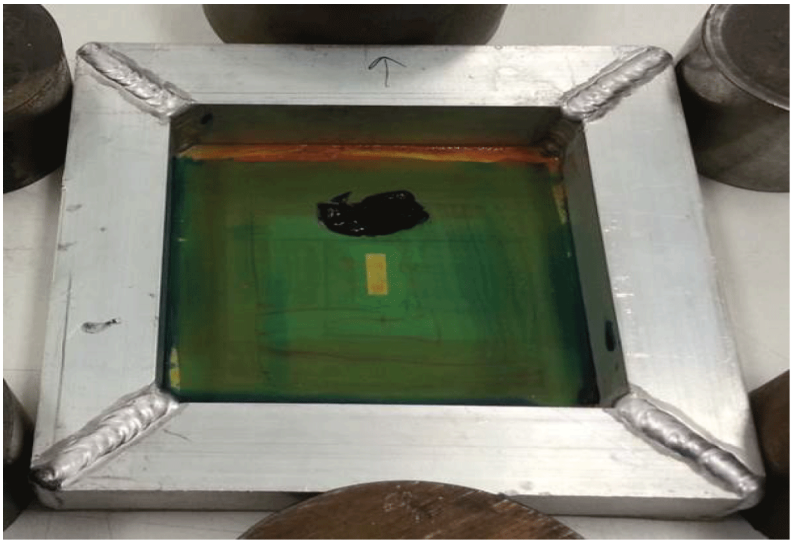

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**Figure 3 – Example of carbon ink deposited on a screen prior to printing**

e) Bring the squeegee back in the reverse direction, still with a small amount of force being applied, to ensure an even coating of the carbon ink is left on the surface of the sample.

f) Remove the screen from the sample with care, so as not to touch the wet ink or for any smearing to occur. See Figure 4 for an example of how the specimen should look after the first screen printing has been completed.



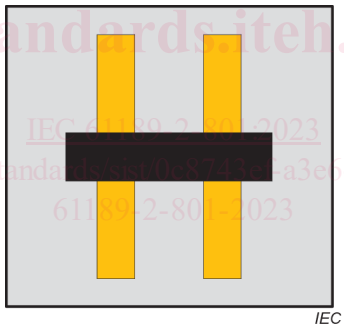

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**Figure 4 – Specimen after first screen printing**

g) Have an oven pre-warmed to 125 °C and place the specimen(s) into it for a period of 20 min.

h) Start by using methyl ethyl ketone (MEK) to clean the mesh screen, which should then be followed with propan-2-ol (IPA).

i) After 20 min have elapsed, remove the specimens from the oven and allow them to cool. Once cooled to room temperature, apply a second layer of carbon ink by repeating steps d) through h). The second layer shall be applied directly to the first layer.

j) Once the specimens have been allowed to cool, use a multimeter to measure the resistance between the two copper electrodes.

k) Any specimen that does not have a measured resistance value of (40 ± 15) Ω shall be discarded.

l) Prepare the hot plate by setting it to a temperature of 225 °C.

m) Deposit sufficient solder paste onto the base of two test pins. One pin should be placed onto each copper electrode, position them at the ends that are closest to the thermocouple hole.

n) When required, excess corrosion should be removed from the copper electrodes using a small volume of flux.

o) Using the hot plate, reflow the solder paste applied to the test pins. This is best achieved by locating the test pins on the hottest part of the hot plate.

p) Once reflow has occurred, carefully take the specimen off the hot plate, making sure not to disturb the test pin. The specimen should now be allowed to cool. See Figure 5 for an example of how the completed specimen should look.

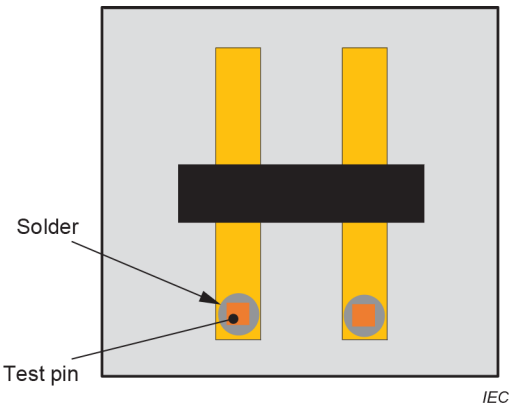


**Figure 5 – Finished specimen**

q) Steps j) and k) shall now be repeated.

## 6 Materials and equipment

a) microdrill with a 0,55 mm drill bit;
b) 195-mesh screen with a 12 mm × 5 mm aperture in a frame 101,6 mm × 101,6 mm;
c) carbon ink with a resistance of approximately 100 Ω/sq;
d) hard rubber (70 Shore A) squeegee for screen printing;
e) polyimide tape, 12,5 mm or 25,4 mm wide;
f) forced air oven;
g) methyl ethyl ketone (MEK);
h) propan-2-Ol (IPA);
i) a digital multimeter;
j) hot plate capable of achieving at least 250 °C;
k) solder paste;
l) SMD test-point pins;
m) digital acquisition system;
n) computer with DAQ software installed or equivalent;
o) microcontroller with sensor conversion software;
p) programmable power supply with USB or GPIB interface or equivalent;
q) USB or GPIB interface or equivalent;
r) thermal grease;
s) wooden tongue depressors;
t) infinite heat sink fixture with a pneumatic cylinder ram;
u) fluid heater unit;
v) thermocouple probe – type T;
w) fluid chiller unit;
x) infrared (IR) sensor and bridge with amplifying electronics;
y) black microhook connector with 2 attached wires;
z) red microhook connector with 2 attached wires;
aa) wet sander;
bb) permanent marker, black, extra-fine tip.

# 7 Procedure

## 7.1 Pre-conditioning

Samples should be conditioned at 23 °C ± 2 °C, 50 % RH for 24 h prior to testing, where possible, and unless otherwise specified.

## 7.2 Test conditions

The laboratory conditions during testing should be 23 °C ± 2 °C, 50 % RH.

## 7.3 Equipment set-up

a) Using the digital acquisition system, attach the thermocouple probe wire to channel 0.

b) Take the red microhook and connect one of the wires to the positive (+) output of the power supply. The second wire should then be connected to the 0 + voltage input channel of the digital acquisition system. Repeat the process for the black microhook connector using the equivalent negative (−) connection points.

c) Connect the interface equipment to the controlling PC, where applicable, and the DC power supply turned on. The power supply should be allowed to stabilise for a minimum of 30 min.

## 7.4 Equipment calibration

a) Start the heating unit and allow it to stabilise at 85 °C to 90 °C.

b) The microcontroller with sensor conversion software and digital acquisition system are to be connected to the controlling PC and turned on. The digital acquisition system should now be allowed to stabilise for 30 min.

c) Using the same sample form as defined in 5.2, remove both copper bars from the dielectric surface and then screen print carbon ink onto the complete surface area. This will be the calibration specimen.

d) Take one of the tongue depressors and break into half, giving two pieces that are approximately 5 mm × 25 mm in size. Set these aside for later use.

e) Take the calibration specimen created in point c) and apply a thin layer of thermal grease on the reverse side. Then place this sample onto the centre of the infinite heat sink plate.

f) Heat the plate and specimen to a temperature of 85 °C to 90 °C using the hot water circulator.

g) Take the two pieces of tongue depressor from point d) and place them on the opposite edges of the top of the calibration specimen, then place the IR sensor and bridge onto the two pieces of the tongue depressor. Apply the pneumatic ram. See Figure 6 for an example of the sensor calibration set up.

h) Fit the thermocouple probe into the calibration specimen and initiate the calibration software.

i) Shut off the heater and connect the chiller plate to the cooling unit. Bring the system down to a temperature of 30 °C to 35 °C.