# IEC 61189-5-501

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# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

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## Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-501: General test methods for materials and assemblies – Surface insulation resistance (SIR) testing of solder fluxes

## Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles – Partie 5-501: Méthodes d'essai générales pour les matériaux et les ensembles – Essais de résistance d'isolement en surface (RIS) des flux de brasage

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## Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-501: General test methods for materials and assemblies – Surface insulation resistance (SIR) testing of solder fluxes

## Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles – Partie 5-501: Méthodes d'essai générales pour les matériaux et les ensembles – Essais de résistance d'isolement en surface (RIS) des flux de brasage

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

## Part 5-501: General test methods for materials and assemblies – Surface insulation resistance (SIR) testing of solder fluxes

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| 91/1645/CDV | 91/1672/RVC |

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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 5-501: General test methods for materials and assemblies – Surface insulation resistance (SIR) testing of solder fluxes

## 1 Scope

This part of IEC 61189 is used to quantify the deleterious effects of flux residues on surface insulation resistance (SIR) in the presence of moisture.

Interdigitated comb patterns comprising long parallel electrodes on an IPC B53 standardized test coupon are used for the evaluation. Coupons are conditioned and measurements taken at a high temperature and humidity. The electrodes are electrically biased during conditioning to facilitate electrochemical reactions, as shown in Figure 1 and Figure 3.

Reference can be made to IEC TR 61189-5-506, which examines different geometry comb patterns: 400 μm x 500 μm; 400 μm x 200 μm; and 318 μm x 318 μm.

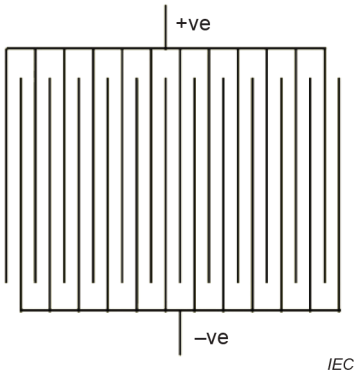


**Figure 1 – SIR pattern**

Specifically, this method is designed to simultaneously assess:

- leakage current caused by ionized water films and electrochemical degradation of test vehicle, (corrosion, dendritic growth);
- provide metrics that can appropriately be used for binary classification (e.g. go/no go; pass/fail);
- compare, rank or characterize materials and processes.

This test is carried out at high humidity and heat conditions.

## 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 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

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

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

IEC 60194-2, *Printed boards design, manufacture and assembly – Vocabulary – Part 2: Common usage in electronic technologies as well as printed board and electronic assembly technologies*

IEC 61189-5-504, *Test methods for electrical materials, printed board and other interconnection structures and assemblies – Part 5-504: General test methods for materials and assemblies – Process ionic contamination testing (PICT)*

IEC TR 61189-5-506, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-506: General test methods for materials and assemblies – An intercomparison evaluation to implement the use of fine pitch test structures for surface insulation resistance (SIR) testing of solder fluxes in accordance with IEC 61189-5-501*

IEC 61190-1-3, *Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solder for electronic soldering applications*

IEC 61249-2-7, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test), copper-clad*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60068-1, IEC 60068-2-58, IEC 60194-2, and IEC 61190-1-3 apply.

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## 4 Equipment/Apparatus

### 4.1 Measurement instrument

This shall consist of a measuring device capable of measuring insulation resistance in the range of at least $10^6$ Ω to $10^{12}$ Ω.

It shall be capable of measuring and recording each individual test channel/pattern. The measurement circuit shall incorporate a 1 MΩ current limiting resistor in each current pathway.

The tolerance of the total measurement system shall be

- ±5 % up to $10^{10}$ Ω at 5 V;
- ±10 % between $10^{10}$ Ω to $10^{11}$ Ω at 5 V;
- ±20 % above $10^{11}$ Ω at 5 V.

If a different test voltage is to be used, the measurement circuit shall be assessed at that voltage rather than the 5 V stipulated. See Clause A.5 for additional information on test voltages.

The resistors used to confirm the ‘total measurement system tolerance’ defined above, shall have a purchased tolerance of

- ±0,1 % up to and including $10^6$ Ω;
- ±1 % above $10^6$ Ω and up to and including $10^8$ Ω;
- ±5 % above $10^8$ Ω and up to and including $10^{10}$ Ω;
- ±10 % above $10^{10}$ Ω.

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The instrument can be used with either an external or internal power supply but shall be capable of delivering a variable voltage from (5 to 100) V DC ±1 % with a 1 MΩ load and a channel to channel isolation resistance of $10^{13}$ Ω.

The system shall be capable of taking measurements in the time interval required.

Equipment shall have the measurement capability to repeat the resistance measurement on all channels at least every 20 minutes.

### 4.2 Resistor verification coupon

The measurement system measurement performance shall be verified by substituting a resistor verification coupon (see Figure 2) in place of the test coupons while in the chamber at both ambient and elevated conditions. This coupon should be fitted with at least 4 “known value” resistors. The tolerances for the “known value” resistors shall be as per the purchased tolerances defined in 4.1.

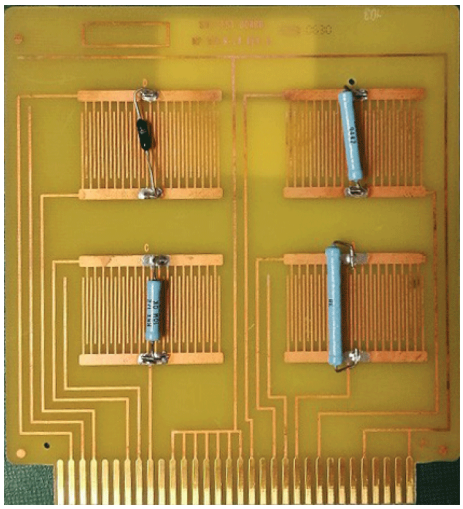

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**Figure 2 – Example of a resistor verification coupon**

### 4.3 Damp heat chamber

A damp heat chamber capable of being adjusted to a temperature of 20 °C ± 2 °C to 100 °C ± 2 ˚C and of relative humidity between 80 % RH ± 3 % RH and 90 % RH ± 3% RH according to IEC 60068-2-67 and IEC 60068-2-78 shall be used.

If the alternative conditions of 40 °C / 93 % RH are to be used, the damp heat chamber shall be capable of the upper humidity level of 93 % RH ± 3 % RH rather than the 90 % RH ± 3% RH specified above. See 5.7.1 and Clause A.4 for additional information.

The chamber should be constructed with stainless steel inner surfaces and be well insulated. The temperature and humidity measurement should be taken using sensors such as dry and wet bulb thermometers or solid-state sensors. The temperature and humidity levels of the test chamber shall be recorded at a minimum of 5 minute intervals throughout the test, preferably with independent control sensors.

The location of the samples within the chamber should ensure that the airflow within is not impeded.

Adequate mixing of water vapour and air is imperative to ensure condensation does not occur anywhere in the chamber except on/around cooling or dehumidification coils. If any part of interior of the chamber is below the dew point, possibly due to insulation or control issues, condensation will occur. The samples shall be kept above the dew point and be shielded from dripping or flying condensate.

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The chamber interior shall be free from any unwanted residues from previous tests. The chamber should have been dedicated to heat and humidity testing only and not used for tests such as salt fog, salt mist or salt spray.

### 4.4 Additional apparatus

#### 4.4.1 Ionic contamination test system

If the user does not have an ionic contamination test system, as described in IEC 61189-5-504, then the following additional items shall be needed:

- lint-free handling gloves;
- three 2 l beakers;
- exhaust ventilation hood;
- metal tongs;
- soft bristle brush;
- deionised or distilled water maximum 15 µS/cm of sufficient volume to carry out cleaning as per 6.2;
- propan-2-ol (IPA) of sufficient volume to carry out cleaning as per 6.2.

#### 4.4.2 Drying oven

Capable of maintaining at least 50 °C.

#### 4.4.3 Camera

A camera for recording full colour photographs of test coupons.

#### 4.4.4 Backlight panel

Suitable for inspecting test coupons after testing for evidence of dendritic growth or other anomalies.

## 5 Test coupons

### 5.1 General

It has been the practice for different test coupons to be used that has led to confusion in respect to comparing test results. In addition, previous revisions of this and other test methods, have conflicting requirements in respect to the voltage gradient and test voltages to be used. To resolve this confusion, a comprehensive “round-robin” research study was conducted that employed a new test coupon that includes test pattern characteristics of the following test coupons: IPC B24; “Bellcore”; IEC 61189-5 Method 5E01.

The full technical report IEC TR 61189-5-506 of this separate research study should be reviewed.

### 5.2 IEC TB144 (IPC B53) test coupon

The test pattern IEC TB144 from IEC TR 61189-5-506, now known as IPC B53 and shown in Figure 3, shall be used for the test coupon. The 6 comb patterns comprise A and F patterns of 0,4 mm line width and 0,2 mm spacing, comprising 5 125 squares (IEC 61189-5 Method 5E01); B and E patterns have 0,4 mm line width and 0,5 mm spacing, comprising 1 020 squares (IPC B24); C and D patterns have 0,318 mm line width and 0,318 mm spacing, comprising 1 950 squares (Bellcore).

Pattern G (the central Y pattern), and the squares and dots (adhesion test pattern) identified as A and B, are not a requirement for SIR testing; all other test patterns shall be evaluated as part of this test.

The coupon is approximately 150 mm × 95 mm in size. The conductive patterns shall be either unpreserved bare copper or finished with electroless nickel gold (ENIG).

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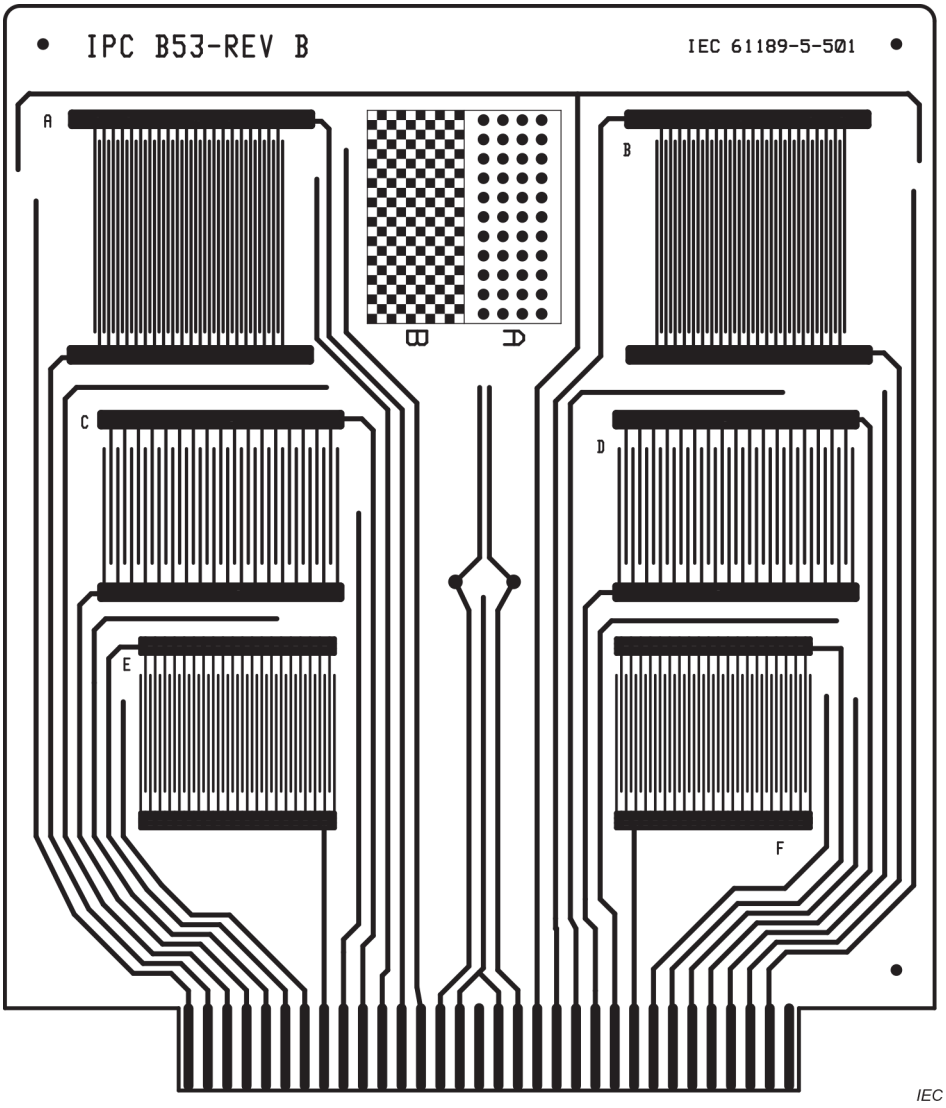


**Figure 3 – IPC B53 Surface insulation resistance pattern**

### 5.3 Laminate

The laminate material for this test coupon shall be an epoxide woven E-glass laminated sheet in accordance with IEC 61249-2-7.

### 5.4 Coupons for testing

The type and number of test coupons as well as method of preparation and test requirements should be described in the governing specification or procurement documentation; see Annex A for recommendations.

The coupons shall be handled in a way that minimizes the possibility of contamination such as from finger salts. Refer to 6.2.

### 5.5 Chamber controls

Two cleaned bare IPC B53 test coupons shall be used as chamber controls.

Visually inspect the coupons for any obvious defects. If there is any doubt about the overall quality of any test coupon, it shall be discarded.

Prior to running a test, the chamber should be run at the intended test conditions for not less than 8 h. This should be carried out after 60 days of test operations to minimise the risk of any residues influencing subsequent tests.

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Before commencing each test, the interior surfaces of the chamber shall be wiped using propan-2-ol (IPA) and a suitable lint-free cloth.

### 5.6 Blank process controls

It is recommended that a single bare control coupon be included in each test.

### 5.7 Test conditions

#### 5.7.1 Fluxes not intended for cleaning

If the flux contains more than 1 % by weight organic acid activators, such as adipic acid that volatilise significantly at 85 °C, and contain less than 5 % by weight rosin or modified-rosin resin, the test shall be conducted at 40 °C ± 2 °C and 90 % RH ± 3 % RH.

As an alternative to 40 °C ± 2 °C and 90 % RH ± 3 % RH, it is acceptable to use 40 °C ± 2°C and 93 % RH ± 3%. If 93 % RH is desired to be used instead of 90 % RH (at 40 °C), this shall be agreed between user and supplier prior to use. Using 93 % RH could lead to different results when compared to using 90 % RH. See Clause A.4 for additional details.

#### 5.7.2 Fluxes intended for cleaning

If the flux contains more than 0,1 % by weight ionic halide and the intended end-product is to be cleaned, the test shall be conducted at 85 °C ± 2 °C and 85 % RH ± 3 % RH.

### 5.8 Test duration

The test duration shall be not less than 72 h.

### 5.9 Test voltage

Testing shall be conducted using a test and measurement voltage of 5 V DC. Alternative voltages are acceptable, if agreed between user and supplier. See Clause A.5 for additional information on test voltages.

### 5.10 Connecting the test coupons

#### 5.10.1 General

The interconnecting cabling between the measurement instrument and the test coupon shall ensure accurate and reliable measurements to be recorded, as the measurements are being made at pico-Amp levels $>10^{10}$ Ω.

Halogen-Free, shielded, cable should be used so as to minimise any electrical noise or tribo-electrical interference.

The connection of the test coupons to the measurement system may be done in 1 of 2 ways as described in 5.10.2 and 5.10.3.

#### 5.10.2 Connector/test rack

This comprises a set of connectors that shall be suitable for the test coupons and able to tolerate the test environment over repeated test cycles, see Figure 4 and Figure 5 for examples.

These connectors shall be mounted onto a suitable support frame. An electro-polished stainless steel frame is the most durable type but others may be employed provided that they will not adversely influence the test measurements.

There shall be a measurement cable soldered in the appropriate pattern that is secured to the frame for connection to the measurement system.

Prior to connecting test coupons to the measurement system, each cable assembly shall be connected to a resistor verification coupon (see 4.2) inside the humidity chamber at ambient conditions and a measurement taken. Any cable that does not read within the tolerance value of the total measurement system, as defined in 4.1, shall be reworked or replaced.

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