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**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 61189-5-504:2020](#)

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**Méthodes d'essai pour les matériaux électriques, les cartes imprimées et autres structures d'interconnexion et ensembles –
Partie 5-504: Méthodes d'essai générales pour les matériaux et les ensembles –
Essai de contamination ionique des procédés (PICT)**



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ELECTROTECHNICAL
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ICS 31.180

ISBN 978-2-8322-8111-6

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

**Part 5-504: General test methods for materials and assemblies –
Process ionic contamination testing (PICT)**

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International Standard IEC 61189-5-504 has been prepared by IEC technical committee 91: Electronics assembly technology.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
91/1639/FDIS	91/1644/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.

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

Part 5-504: General test methods for materials and assemblies – Process ionic contamination testing (PICT)

1 Scope

This part of IEC 61189 is a test method designed to determine the proportion of soluble ionic residues present upon a circuit board, electronic component or assembly. The conductivity of the solution used to dissolve the ionic residues is measured to evaluate the level of ionic residues.

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.

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

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

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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 60079-7, *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*

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

IEC 61189-5-502, *Test methods for electrical materials, printed boards and other interconnection structures and assemblies – Part 5-502: General test methods for materials and assemblies – Surface insulation resistance (SIR) testing of assemblies*

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*

IPC-TM-650 method 2.6.3.7, *Surface Insulation Resistance*

IPC 9202, *Material and Process Characterisation / Qualification Test Protocol for Assessing Electrochemical Performance*

IPC 9203, *Users Guide to IPC 9202 and the IPC-B-52 Standard Test Vehicle*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60068-1, IEC 60068-2-20:2008, IEC 60068-2-58, IEC 60194, and IEC 61190-1-3 apply.

4 General description of the test

The test measures the conductivity of a test solution that comprises a mixture of de-ionised water and alcohol (propan-2-ol). The test equipment shall measure the total current flow and the result shall be expressed as an equivalence of sodium chloride (NaCl) mass per unit area ($\mu\text{g}/\text{cm}^2 \equiv \text{NaCl}$).

The test is used to monitor levels of ionic residues of printed circuit boards, electrical and electronic components or printed circuit assemblies. The measured values are compared to the user's performance specification.

Ionic residues emanate from multiple processes during the manufacture of electronic circuit boards, components and assemblies. Examples of ionic residues include: ammonium chloride – citric acid – diethylamine hydrochloride – hydrochloric acid – methylamine hydrohalide – sulphuric acid – finger salts – carboxylic acid.

When an ionic contaminant comes into contact with water, the conductance value of the water will increase owing to the dissolution of the contaminant into the water. If the surface area and the type of contamination are also known it is possible to express the amount of contamination present, as a given weight per unit area of board.

This test does not measure any surface ionic materials that are not brought into solution owing to insolubility, physical entrapment or inadequate exposure to the extracting solvent. Additionally, non-ionic components of the soil are not measured. Not all ionic contaminants are easily soluble in water, particularly those trapped within process residues such as solder flux. These contaminants do however have increased solubility in alcohol.

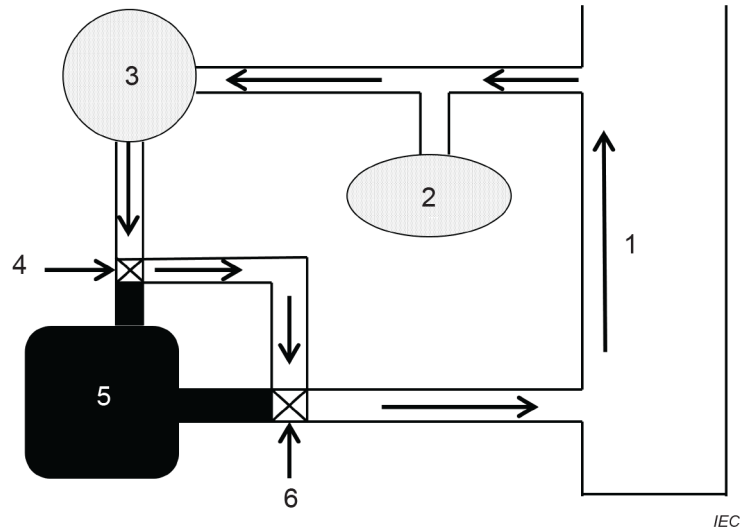
The addition of a strongly ionized salt to deionized water will enhance its electrical conductance to a degree that is nearly proportional to the concentration of the salt. Conductance measurement can thus be used to indicate concentration of an ionic salt extracted into a solution.

Amounts of ionic materials in the test solution are expressed by a conductivity factor that is equivalent to the measured conductivity contributed by a known amount of a standard, strongly ionized salt such as sodium chloride (NaCl). Ionic residues are therefore usually expressed as equivalents of sodium chloride in micrograms per unit surface area ($X \mu\text{g}/\text{cm}^2 \equiv \text{NaCl}$) of the sample under test. This does not imply that the contamination is NaCl, but that it exhibits conductivity equivalence to that of the expressed amount of NaCl if it were in solution instead of the ionic soil.

Measurements of ionic conductivity obtained by this test method do not differentiate between different ionic species, they simply measure conductivity that can be related to the total amounts of ionic materials present in the test solution.

5 Test apparatus

The test requires measurement apparatus, corresponding generally to that shown in Figure 1.



Key

- 1 test chamber
- 2 measurement cell
- 3 recirculation pump
- 4 control valve(s)
- 5 regeneration filter column
- 6 control valve(s)

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Figure 1 – Typical test instrument

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6 Materials <https://standards.iteh.ai/catalog/standards/sist/09ab1961-06c5-4541-9469-0d34a1732975/iec-61189-5-504-2020>

6.1 Test solution

6.1.1 General

Ionic soils can be dissociated in water, and the conductance measured to give an indication of the contaminate level. The test solution however is more than just water; it contains propan-2-ol, a non-polar liquid that aids the dissolution of the soil and, as a non-ionic hydrophilic solvent, its presence does not influence the reading except insofar as it "dilutes" the water bearing the dissociated ions. The test employs a test solution that comprises a specific ratio of 50 % *V/V* propan-2-ol and 50 % *V/V* deionised water or 75 % *V/V* propan-2-ol and 25 % *V/V* de-ionised water.

The 50:50 mixed solution is an optimal compromise between the sensitivity and the solvency when using immersion test methods.

The 75:25 mixed solution with the higher alcohol content will reduce sensitivity but increase solvency and vice versa with respect to water.

6.1.2 Deionised water (DI)

The detection of ionic impurities in water uses a well-established conductivity test method. The electrical conductivity of pure water is 0,055 µS/cm at 25 °C. This value is temperature-dependent.

The addition of 1×10^{-9} parts of NaCl increases the conductivity of pure water from 0,055 $\mu\text{S}/\text{cm}$ to 0,057 $\mu\text{S}/\text{cm}$ at 25 °C [1]¹.

6.1.3 Propan-2-ol

Propan-2-ol, also commonly known as iso-propyl alcohol (IPA), is used to increase the dissolution of ionic material that is inorganic in nature and trapped by an organic residue.

6.2 Calibration solution

The calibration solution contains a known value of NaCl, typically 0,1 %, and deionised water. The calibration solution shall be marked with an expiry date and shall not be used beyond this expiry date.

6.3 Test chamber

For optimum accuracy, the relationship between the test specimen surface area and the volume of test solution in the test chamber should be 1cm² per 10 ml [2].

When testing smaller specimens, the size criterion can be met by testing multiple specimens simultaneously.

The test chamber should always have a lid to minimise the absorption effect of surrounding CO₂ and other pollutants.

6.4 Regeneration filter column

The regeneration filter column contains a pre-mixed de-ionising resin that comprises chelate, cation and anion resins.

The test solution is pumped through the filter column where, by ionic exchange, the solution is polished until it reaches a predetermined level of conductivity < 0,1 $\mu\text{S}/\text{cm}$.

6.5 Recirculating pump

The test solution is re-circulated by using a pump that shall comply with IEC 60079-7.

6.6 Measurement system capability

The measurement system shall have an accuracy of $\pm 0,05 \mu\text{S}/\text{cm}$.

The instrument should be capable of avoiding polarisation effects between electrodes such as those that can occur when using DC test currents. Equally, error signals caused by both DC and AC currents should be avoided to ensure optimum accuracy at low conductivity values.

7 Test procedure

7.1 Test apparatus

The test can be run using one of two variants of test apparatus:

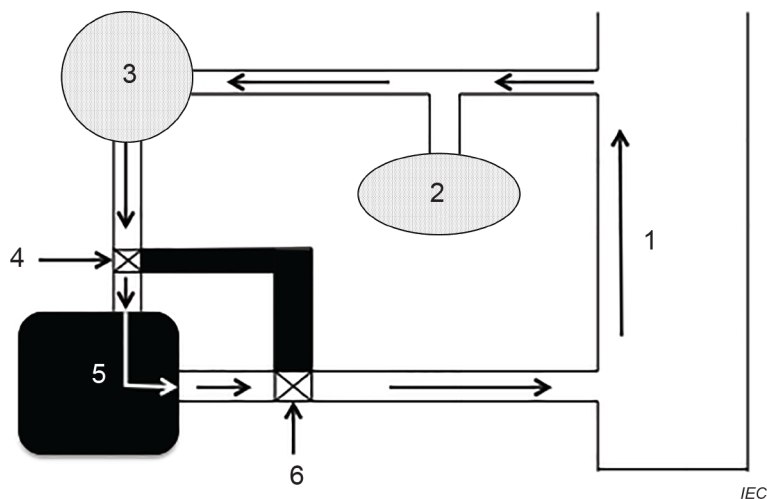
- closed loop (preferred),
- open loop.

¹ Numbers in square brackets refer to the Bibliography.

7.2 Closed loop

The test solution in the test chamber is pumped via the regenerating filter, until it reaches a predetermined level of conductivity.

The test specimen is introduced into the test chamber and the test solution begins to recirculate, bypassing the filter (see Figure 2 and Figure 3).



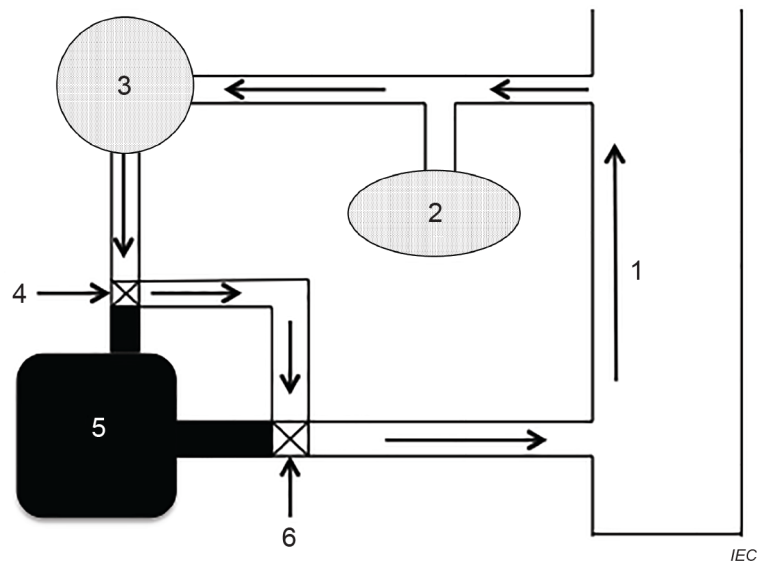
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Key

- 1 test chamber
- 2 measurement cell
- 3 recirculation pump
- 4 & 6 control valves
- 5 regeneration filter column

Figure 2 – Closed-loop method in regeneration mode

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**Key**

- 1 test chamber
- 2 measurement cell
- 3 recirculation pump
- 4 & 6 control valves
- 5 regeneration filter column

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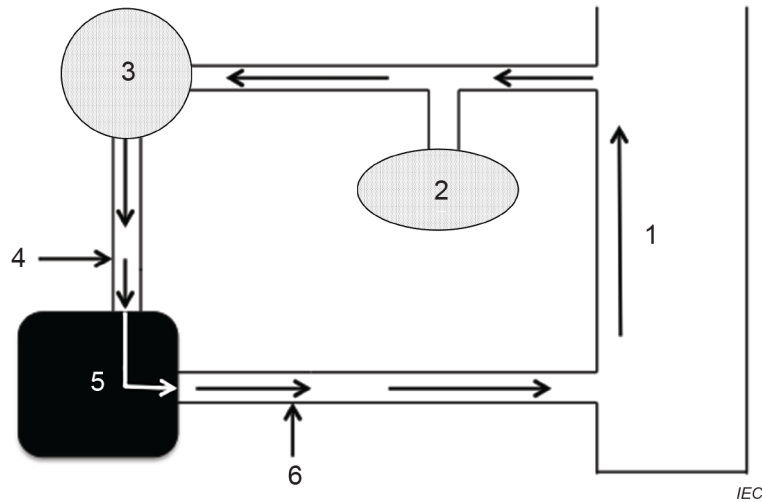
Figure 3 – Closed loop in test mode

[IEC 61189-5-504:2020](https://standards.iteh.ai/catalog/standards/sist/09ab1961-06c5-4541-9469-0d34a1732975/iec-61189-5-504-2020)

7.3 Open loop <https://standards.iteh.ai/catalog/standards/sist/09ab1961-06c5-4541-9469-0d34a1732975/iec-61189-5-504-2020>

The test solution in the test chamber is pumped via a regenerating filter comprising a mixture of chelate, cation and anion resins, until it reaches a predetermined level of conductivity.

The test specimen is introduced into the test chamber and the test solution begins to recirculate, through the filter (see Figure 4).



Key

- 1 test chamber
- 2 measurement cell
- 3 recirculation pump
- 4 & 6 control valve(s)
- 5 regeneration filter column

Figure 4 – Open loop method
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7.4 System verification

7.4.1 General

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The specific gravity and temperature of the test solution shall be checked at least once per working shift before using the system.

7.4.2 Polishing the test solution

The test solution is re-circulated through the regeneration filter column containing mixed resin that shall "polish" the solution to a conductivity level of 0,1 µS/cm.

7.4.3 Recording test solution temperature and specific gravity

Check and record the test solution temperature and verify the specific gravity (SG) using a hydrometer. The SG for the 50 % V/V to 50 % V/V test solution should be at a density of 0,921 ± 0,020 at 20 °C.

For other temperatures, refer to Figure 5.

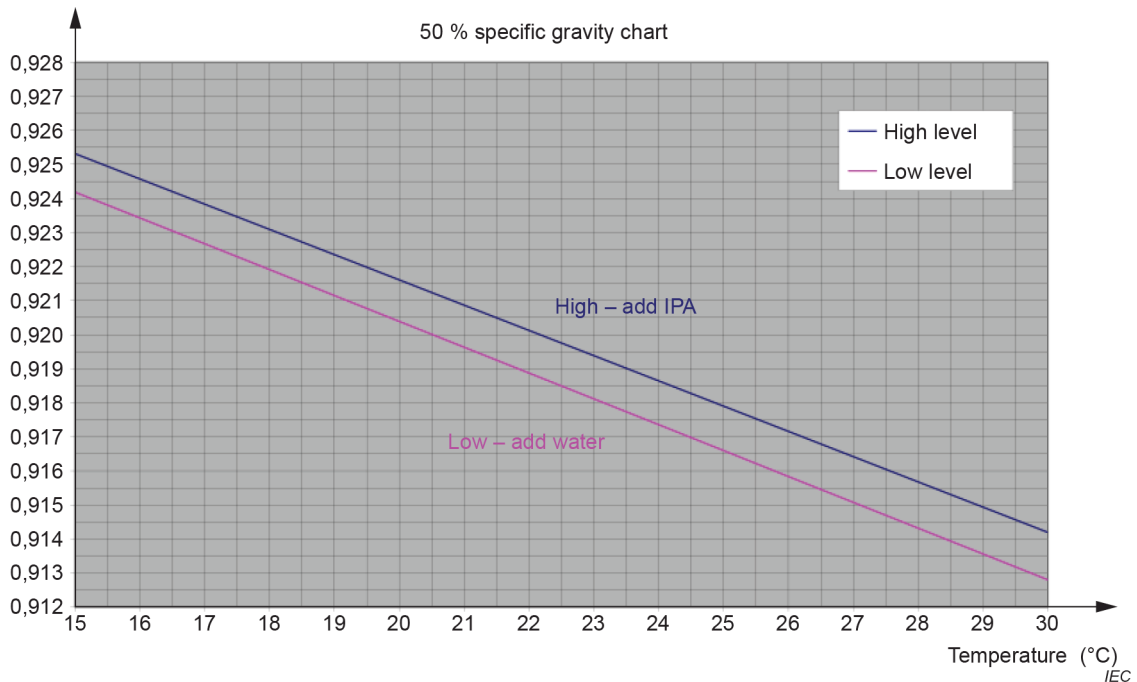


Figure 5 – 50 % specific gravity chart

The SG for the 75 % *V/V* to 25 % *V/V* test solution should be at a density of $0,858\ 5 \pm 0,020$ at $20\ ^\circ\text{C}$.

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For other temperatures refer to Figure 6.

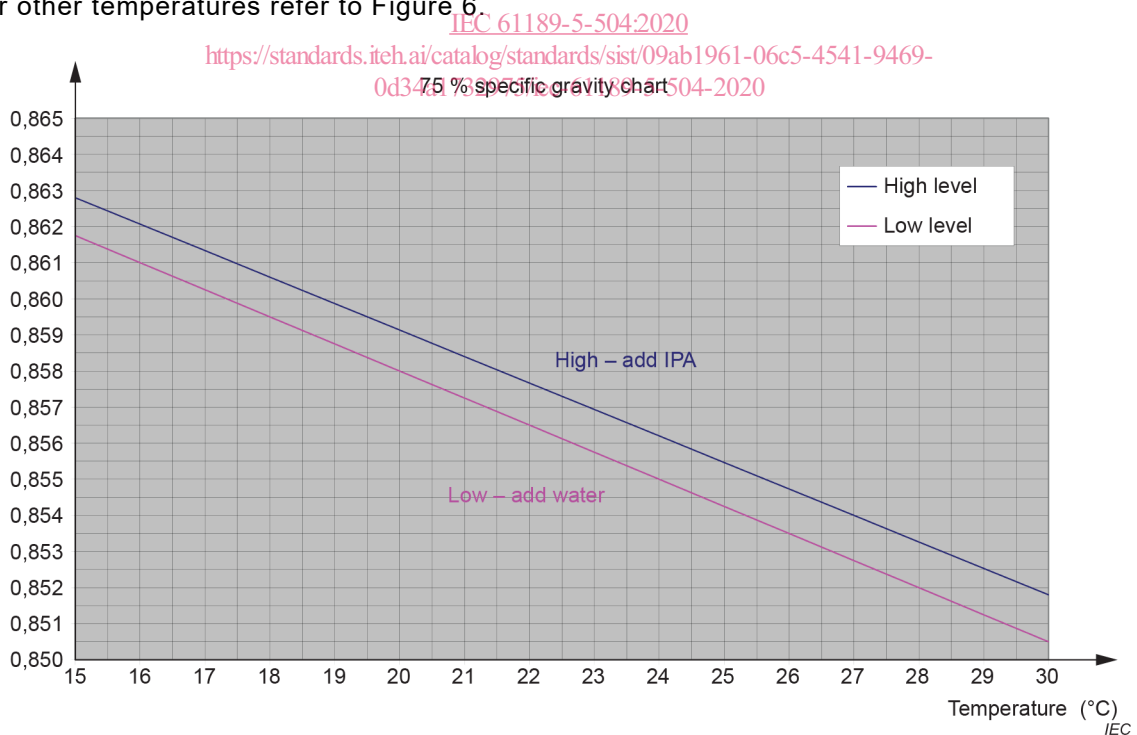


Figure 6 – 75 % specific gravity chart

7.4.4 Checking conductivity accuracy

Cycle the instrument to the pre-test starting condition, as specified by the manufacturer, which is typically lower than $0,05\ \mu\text{S}/\text{cm}$.