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IPC-TM-650 TEST METHODS MANUAL

1 Scope

1.1 Purpose These tests are used as process control tools; they can be used to inspect printed boards or printed board assemblies and determine if they conform to the monitoring level of the user's performance specification. Bulk ionic cleanliness testing may be accomplished by measuring the ionizable surface contaminants extracted by the following three methods:

1. Manual extraction method
2. Dynamic extraction method
3. Static extraction method

Note: Please note that this method does not predict reliability and should only be used as a process control tool.

1.2 Restrictions Measurements of ionic conductivities do not differentiate between different ionic species. They simply measure conductivities (or resistivities) which can be related to amounts of ionic materials present in solution. There is no identification of the contribution to the total conductivity readings of any individual ionic species which may be extracted into the solution. For measurement of individual ionic species (type and level of residue) see IPC-TM-650, Test Method 2.3.28, Ionic Analysis of Circuit Boards, Ion Chromatography Method.

For simplicity, amounts of ionic materials in solution can be expressed by a conductivity factor which 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 (e.g., $\mu\text{g NaCl Eq./cm}^2$) of the sample. This does not imply that the contamination is NaCl but, rather, it exhibits a conductivity function which is equivalent to that of the expressed amount of sodium chloride if it were in solution instead of the ionic soil.

These tests will not measure any surface ionic materials which are not brought into solution because of insolubility, physical entrapment or inadequate exposure to the extracting solvent. Additionally, non-ionic components of the soil will not be measured.

1.3 Application Caution should be exercised in comparing results between different test equipment as well as the differ-

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ent test methods. These methods are applicable as quality control tools in evaluating the parameters of materials and cleaning process, in terms of how they affect the final cleanliness of the board or assembly. As process control tools, they can be used to inspect printed wiring boards or printed wiring assemblies and determine if they conform to the requirements of the user's performance specification. It is important to understand, no calculation factor can exist to convert data from one style of commercial tester to another due to the great differences in system responses. See IPC-TR-583. This means it is very difficult to compare data from different machines. These procedures can also be used to assist in-process development as general residue indicators, to evaluate flux cleanability, solvent efficiency and general improvements of process parameters.

Note: Please note that this method does not predict reliability and should ONLY be used as a process control tool.

2 Applicable Documents

IPC-TR-583 An In-Depth Look at Ionic Cleanliness Testing

3 Test Specimen Follow the equipment manufacturer's recommendations as to sample size. Recommended area calculations for the unpopulated printed board and printed board assembly are the following:

Printed Board Surface Area = Length x Width x 2
 Printed Board Assembly Surface Area = (Length x Width x 2) + (1 x up to 50% of the board area)

Report the surface area used in the calculation and the percentage increased in calculating the surface area of a printed board assembly.

Note: There is no universally accepted method for determining the surface area of components. However, the determination of surface area for components should be established initially and used whenever that assembly style is being tested.

4 Manual Extraction Method

4.1 Description This method describes the manual extraction of ionic material from the surface of a sample. This consists of flushing the board surface with a stream of 2-propanol/DI water mixture and carefully capturing all of the

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extraction solution before measuring the resistivity of the composite sample.

4.2 Test Equipment and Chemicals

4.2.1 Miscellaneous laboratory ware (e.g., beakers, funnels, storage bottles and graduated cylinders). This plastic ware can be high density polyethylene, polymethylpentene (poly-pentene), polypropylene or equivalent. Glassware cannot be used because it has been shown to contribute ionic contamination in a short time with this 2-propanol/DI water solution.

4.2.2 Conductivity bridge or equivalent conductivity probe and temperature compensated liquid conductivity cell apparatus capable of measuring specific resistivities within a range covering at least 100 k Ω -cm to 20 M Ω -cm.

4.2.3 Deionization column. Up to 100% solvent compatible mixed bed or equivalent.

Note: Some of these columns are color dyed. This dye will interfere with test results. Make certain that the column used has no dye.

4.2.4 Electronic Grade 2-Propanol (isopropyl alcohol) or 99.5% purity minimum

4.2.5 Deionized water (DI water), preferably above 16 M Ω -cm water resistivity

Note: It is critical to always use wash solution with the same composition of 2-propanol/DI water for all comparative data discussions.

4.2.6 Wash solution composed of 75 $\pm$ 2% v/v 2-propanol/DI water or 50 $\pm$ 2% v/v 2-propanol/DI water. This wash solution must be deionized to a resistance equal to or greater than 16 M Ω -cm (conductivity less than 0.0625 μ S/cm). If stored, this wash solution must be freshly deionized prior to use. Typical resistivity of 25 M Ω -cm (conductivity of 0.04 μ S/cm) can be achieved. Measurement of the 2-propanol/DI water solution should be performed using a calibrated hydrometer. The default extract solution composition is 75 $\pm$ 2% v/v 2-propanol/DI water.

4.3 Calibration of Bridge This is essential in the manual method because there can be no correlation between resistivity/conductivity readings and NaCl equivalents without calibration. All future specification requirements are to be stated in maximum micrograms of NaCl equivalent per square centimeter (μ g NaCl Eq./cm²).

Note: Ensure that a proper cell constant value is considered in any conductivity calculations. Check the specific conductivity bridge manufacturer's manual for this detail.

4.3.1 Prepare or purchase (these standard solutions are available from equipment vendors, as well as many of the chemical companies) a standard NaCl solution from a weight of ACS reagent grade NaCl salt dissolved in deionized water (16 M Ω -cm resistivity minimum) to produce a final diluted concentration of 0.06 g/liter NaCl (5 mL contains 300 μ g NaCl).

Note: It is recommended that dry NaCl be used for this solution. A recommended drying exposure is one hour at 105 °C or higher.

4.3.2 Place one liter of the 2-propanol/DI water solution (at the calibration temperature of the bridge in use) in a plastic beaker.

Note: The 75%/25% v/v or 50%/50% v/v 2-propanol/DI water solution must be used in this calibration. Water cannot be used since it is not the test solution used in the procedure. The test solution used in this calibration should be made fresh daily.

4.3.3 From a 50 mL burette, add to the liter of test solution, 5 mL of the standard 0.06 g/liter NaCl solution. Stir and measure resistivity/conductivity.

Note: If the resistivity is measured, convert to conductivity by take the reciprocal, prior to plotting the data.

4.3.4 From a 50 mL burette, add to the liter of test solution, 20 additional mL of the standard 0.06 g/liter NaCl solution, for a total of 25 mL. Stir and measure resistivity/conductivity.

4.3.5 From a 50 mL burette, add to the liter of test solution, 25 additional mL of the standard 0.06 g/liter NaCl solution, for a total of 50 mL. Stir and measure resistivity/conductivity.

4.3.6 Plot a three-point nomogram of Conductivity vs. μ g/liter of NaCl. A linear relationship is expected with the use of a linear regression best fit line through the data points. If a multi-range meter is used the curve should not be extended beyond the maximum reading of the meter for that range, unless linearity is proven by additional points obtained by adding more standard salt solution. The nomogram will never cross the zero point of conductivity.

Note: An R² value of 0.99 should be expected before the instrument would be considered calibrated.