INTERNATIONAL STANDARD

ISO 9455-17

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Soft soldering fluxes — Test methods —

Part 17: **Surface insulation resistance comb test and electrochemical migration test of flux residues**

Flux de brasage tendre — Méthodes d'essai —

Partie 17: Essai au peigne et essai de migration électrochimique de résistance d'isolement de surface des résidus de flux

Reference number
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 9455-17 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 12, *Soldering and brazing materials*.

ISO 9455 consists of the following parts, under the general title *Soft soldering fluxes — Test methods*:

— *Part 1: Determination of non-volatile matter, gravimetric method*

— *Part 2: Determination of non-volatile matter, ebulliometric method*

— *Part 3: Determination of acid value, potentiometric and visual titration methods*

— *Part 5: Copper mirror test*

— *Part 6: Determination and detection of halide (excluding fluoride) content*

— *Part 8: Determination of zinc content*

— *Part 9: Determination of ammonia content*

— *Part 10: Flux efficacy tests, solder spread method*

— *Part 11: Solubility of flux residues*

— *Part 12: Steel tube corrosion test*

— *Part 13: Determination of flux spattering*

— *Part 14: Assessment of tackiness of flux residues*

— *Part 15: Copper corrosion test*

— *Part 16: Flux efficacy tests, wetting balance method*

— *Part 17: Surface insulation resistance comb test and electrochemical migration test of flux residues*

Soft soldering fluxes — Test methods —

Part 17:
Surface insulation resistance comb test and electrochemical migration test of flux residues

1 Scope

This part of ISO 9455 specifies a method of testing for deleterious effects that may arise from flux residues after soldering or tinning test coupons. The test is applicable to type 1 and type 2 fluxes, as specified in ISO 9454-1, in solid or liquid form, or in the form of flux-cored solder wire, solder preforms or solder paste constituted with eutectic or near-eutectic tin/lead (Sn/Pb) solders (ISO 9453:1990, Class E).

NOTE This test method is also applicable to fluxes for use with lead-free solders. However, the soldering temperatures may be adjusted with agreement between tester and customer.

2 Normative references

The following referenced documents are indispensable for the application 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.

ISO 5725-2, *Accuracy (trueness and precision) of measurement methods and results — Part 2: Basic method for the determination of repeatability and reproducibility of a standard measurement method*

ISO 9453:1990, *Soft solder alloys — Chemical compositions and forms*

ISO 12224-1:1997, *Solder wire, solid and flux cored — Specification and test methods — Part 1: Classification and performance requirements*

IEC 61249-2-7:2002, *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*

IEC 60068-2-20, *Environmental testing — Part 2: Tests — Test T: Soldering*

IPC-TM-650[1)], *Test Methods Manual (TM 2.6.3.3 Surface Insulation Resistance, Fluxes) (Test pattern IPC-B-24)*

3 Principle

The objective of this test method is to characterize fluxes by determining the degradation of electrical resistance and the electrochemical migration of rigid printed wiring coupon specimens after exposure to the specified flux. This test is carried out at high humidity and heat conditions under bias voltage. For fluxes which may leave undesirable residues and hence require cleaning, the results obtained from the test will depend on the characteristics of the flux residue, substrate, metallization, and also on the effectiveness of the cleaning operation.

1) Obtainable from: IPC, 2215 Sanders Road, Northbrook, IL, 60062-6135.

The measurement of surface insulation resistance (SIR) makes use of a printed wiring coupon substrate having one or more conductive interleaved test patterns. Prior to being subjected to conditioning, the interleaved test patterns are fluxed, soldered or tinned, and cleaned (when required). The patterns are then exposed to a controlled environment for a specified time, with an applied voltage. The surface insulation resistance is measured using insulation test apparatus, at a suitable test voltage while the test coupons are in the controlled environment.

4 Reagents

In the test use only reagents of recognized analytical grade or higher and only distilled, or deionized water, with a conductivity of less than 0,5 µS/cm (resistivity $\geqslant$ 2 MΑ·cm).

4.1 Propan-2-ol, $(CH_3)_2CHOH$ or other suitable solvent.

4.2 Cleaning solvent (where required), recommended by the flux manufacturer as suitable for the removal of post soldering flux residues, or propan-2-ol.

5 Apparatus

Equipment shall be capable of demonstrating repeatability in accordance with the gauge r and R methodology specified in ISO 5725-2.

5.1 Low profile container, e.g. a Petri dish or a watch glass.

5.2 Drying oven, suitable for use at up to 120 °C ± 3 °C.

5.3 Insulated wire or cable, tin coated single copper conductor, 1 000 V general purpose wire, temperature rated to 150 °C; primary insulation of radiation-crosslinked, extruded polyalkene; primary jacket of radiation-crosslinked, extruded polyvinylidene fluoride; configuration suitable for equipment in use.

5.4 Connector, 64-position, glass filled polyester body with the following properties:

— 1,27 mm × 10,67 mm (0,05 in × 0,42 in) on 2,54 mm (0,10 in) centres;

— 32 tabs, gold plated over nickel plate over copper;

— 0,762 µm (0,000 03 in) gold plated post/pin mating end;

— bifurcated beam contacts;

— for coupon thickness of 1,40 mm to 1,78 mm (0,055 in to 0,070 in);

— capable of withstanding temperatures up to 105 °C.

5.5 Test coupon, conforming to IPC B-24, specified in IPC-TM-650 (see Figure 1). It shall be single sided copper clad epoxide woven glass fabric laminate conforming to IEC 61249-2-7 with nominal thickness of 1,5 mm, clad copper foil with a nominal thickness of 18 µm. The final finish of the circuit conductors shall be bare copper (without preservative). This test substrate is referred to as the “test coupon” comprising four (4) “test patterns”. The dimensions of the test coupon shall be 101,6 mm × 114,4 mm (4,0 in × 4,5 in). The connections of the test coupon (connectors with gold-to-gold mechanical contacts) shall be:

— 32 tabs, gold plated over nickel plate over copper;

— 1,27 mm × 10,67 mm (0,05 in × 0,42 in) on 2,54 mm (0,10 in) centres

The test pattern shall be:

- 0,4 mm (0,016 in) width
- 0,5 mm (0,020 in) spacing
- 15,25 mm (0,6 in) overlap
- 34 overlapping spaces
- 1 040 squares (nominal)

NOTE Spaces are determined by counting the number of overlapping areas per pattern. Squares are determined by the following formula:

$$\frac{\text{length of overlap} \times \text{number of spaces}}{\text{spacing width}} \approx 1\,040 \text{ squares}$$

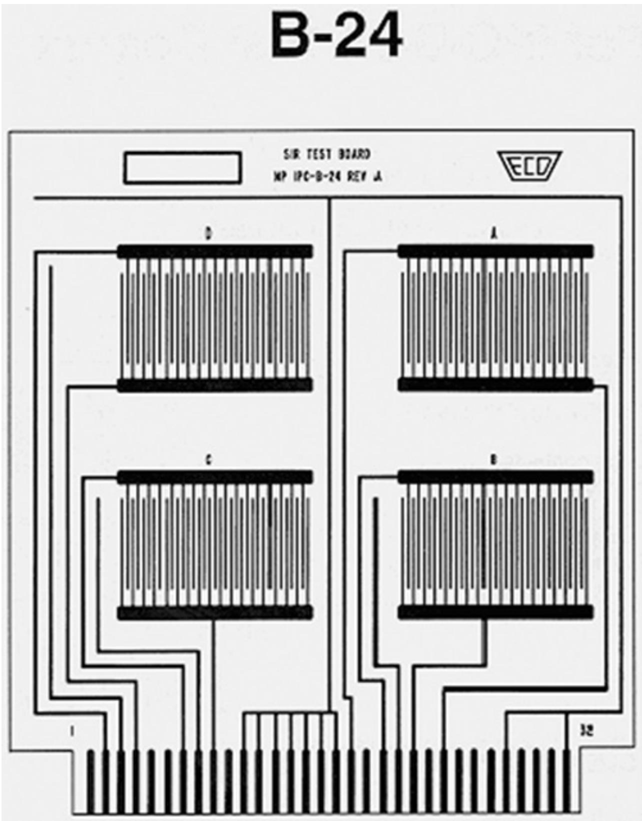


Figure 1 — Resistor verification coupon
(Reproduced with permission)

5.6 Soldering equipment.

5.6.1 Flux-cored solder wire, conforming to S-Sn60Pb40E/1.1.1 or S-Sn63Pb37E/1.1.1 of ISO 12224-1:1997.

NOTE This wire consists of 60/40 or 63/37 tin/lead solder wire with a core of non-activated rosin (colophony) flux (classification 1.1.1, non-activated of ISO 9454-1:1990).

5.6.2 Wave solder system, comprising a wave soldering machine where the solder in the bath shall conform to grade S-Sn63Pb37E of ISO 9453:1990. The set point temperature shall be maintained to ± 5 °C.

5.6.3 Static bath, containing solder to a depth of not less than 40 mm, conforming to grade S-Sn63Pb37E of ISO 9453:1990. The set point temperature shall be maintained to ± 5 °C.

5.6.4 Reflow oven, with controllable temperature profiling.

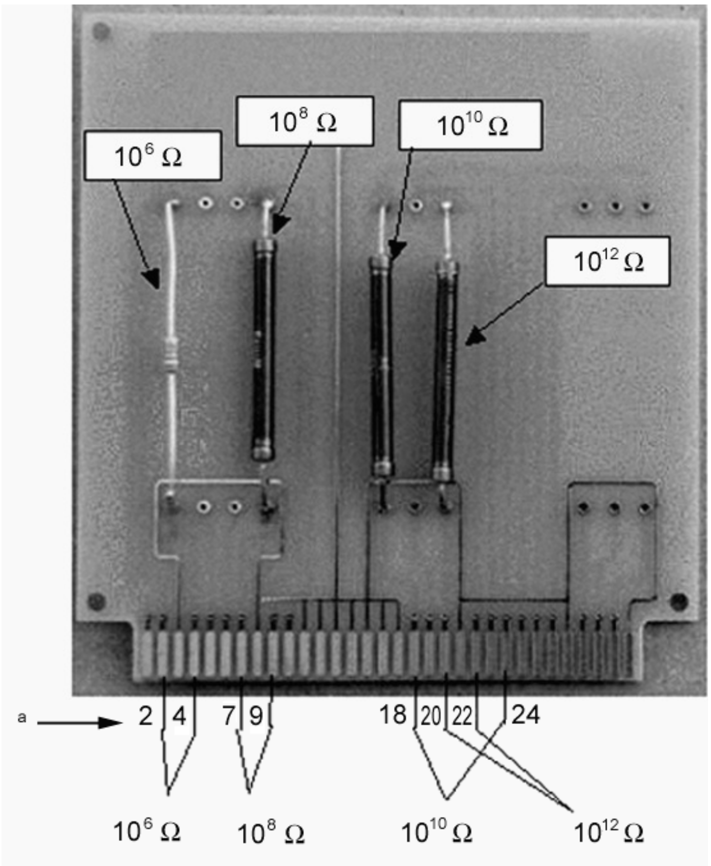
5.6.5 Soldering iron.

5.7 Humidity chamber, capable of maintaining environments up to 90 °C with temperature control of ± 2 °C and relative humidity (RH) up to 95 % with control of ± 3 % at a specific RH set point when loaded with test coupons. The chamber shall be constructed with stainless steel inner surfaces and be well insulated. Some solid state sensors cannot tolerate high temperature and humidity. The temperature and humidity levels of the test chamber shall be recorded throughout the test, preferably with independent control sensors.

NOTE If used, independent temperature and humidity sensors should be located in close proximity to the test coupons. Conformance with these conditions will ensure that uniform test conditions can be maintained while the chamber is under test load.

5.8 High resistance measurement system, capable of measuring surface insulation resistance (SIR) in the range of at least 10^6 Ω to 10^{12} Ω and with a test and bias voltage supply capable of providing a variable voltage from 10 V to 100 V dc (± 2 %) with a 1 MΩ load. The sample selection system shall be capable of individually selecting each test pattern under measurement. The system 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 ± 10 % between 10^{10} Ω to 10^{11} Ω, and ± 20 % above 10^{11} Ω.

5.9 Resistor verification coupon, with the same dimensions as the test coupon with one each 10^6, 10^8, 10^{10} and 10^{12} Ω resistors in specific current pathways as shown on Figure 2. It shall have a protective metal (stainless steel) cover attached with stainless hardware to the grounded mounting holes on the coupon to protect the resistors from contamination or damage during handling (see Figure 3).



[a] Test coupon tab connectors

Figure 2 — Resistor verification coupon

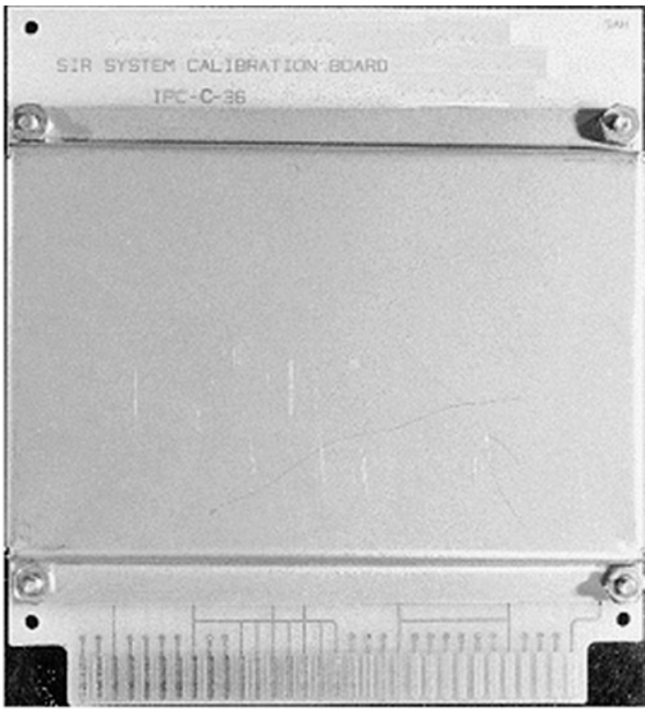


Figure 3 — Resistor verification board with protective cover

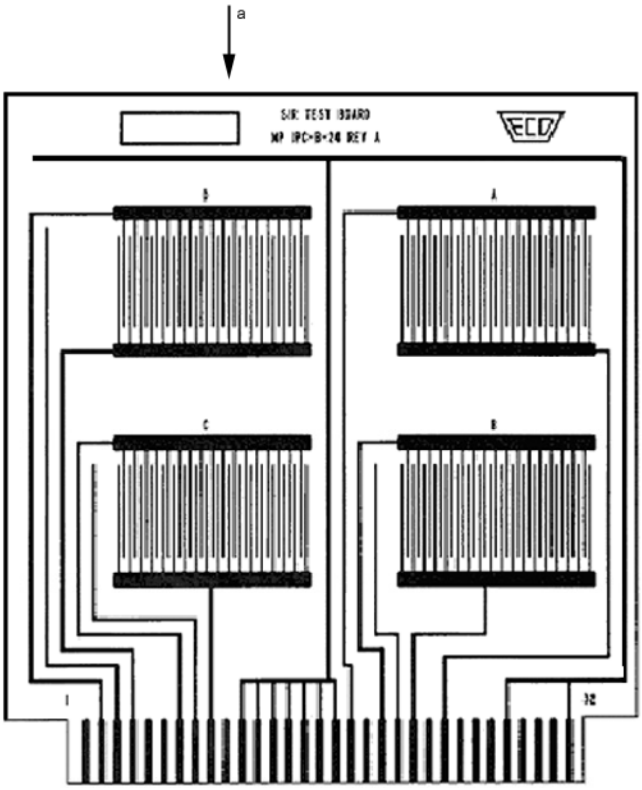
5.10 Soft bristle brush.

5.11 Scapel, doctor blade or equivalent.

5.12 Analytical balance, capable of measuring to an accuracy of 0,000 1 g.

5.13 Test coupon fixing device, capable of uniformly spacing coupons (minimum of 15 mm), parallel to air flow with the connector (if present), in accordance with Figure 4.

5.14 Soxhlet extraction apparatus.



a Air flow

Figure 4 — IPC-B-24 test coupon location with respect to chamber air flow

6 Inspection of test coupons

6.1 Surface plating

6.1.1 Slivering (thin metal overhang on etch runs)

There shall be no slivering on test coupons since the slivers are prone to breaking off with the associated possibility of creating electrical short circuits during SIR testing.

NOTE Slivering is a condition associated with surface plating or etching.

6.1.2 Plating nodules

Plating nodules on the edges of etch runs shall be kept to a minimum and in no case shall nodules violate minimum conductor design electrical spacing requirements. Nodules, if present, shall not be loose and flake on to the laminate substrate.

6.1.3 Plating pits

All conductors and plated-through lands shall be free of plating pits.

Gold plated card edge connector pads shall be free of plating pits that expose copper or nickel.

6.2 Surface laminate

Measles or crazing of the bare printed coupon, if present, shall not exceed 1 % of the coupon area. There shall be no more than 25 % reduction in space between electrically uncommon conductors due to measling or crazing. A separate determination shall be made for each side of the coupon.

NOTE 1 The area of measling or crazing is determined by combining the area of each measle or craze and dividing by the total area of the printed coupon.

NOTE 2 The referee test (destructive) to determine propagation of measling or crazing is to pre-condition the test coupon and then solder-float the specimen on a solder bath at a temperature of (260 ± 5) °C (500 ± 10) °F for a period of 5 s.

Total measling or crazing of the assembled test coupon shall not exceed 2 % of the test coupon area. There shall be no more than a 50 % reduction in the space between electrically uncommon conductors.

NOTE 3 The area of measling or crazing is determined by combining the area of each measle or craze and dividing by the total area of the printed coupon. A separate determination is made for each side of the coupon.

Conductor edges, if not smooth and even, shall be within design tolerances.

7 Sample preparation

7.1 Preparation of the flux test solution

7.1.1 Liquid flux samples

Use liquid flux samples, as received (i.e. unmodified), as the flux test solution.

7.1.2 Solid flux samples

Prepare a solution of the solid flux sample in accordance with the flux manufacturer's instructions.

7.1.3 Flux cored solder wire or preform samples

If a sample of the flux used in the cored solder wire or preform is not available from the flux manufacturer, then use the following method to prepare samples.

Cut a length of the flux cored solder wire or preform, weighing approximately 150 g and seal the ends by crimping. Wipe the surface clean with a cloth moistened with propan-2-ol (4.1). Place the sample in a beaker, add sufficient water to cover the sample, and boil for 5 min to 6 min. Remove the sample, rinse it with propan-2-ol and allow to dry.

Protecting the solder surface from contamination, cut the sample into 3 mm to 5 mm lengths, using a scalpel (5.11) and avoid crimping the cut ends. Weigh and place the cut segments into the extraction tube of a clean

Soxhlet extraction apparatus (5.14) and extract the flux with propan-2-ol, or other suitable solvent (4.2), until the return condensate is clear. Calculate the approximate non-volatile matter content of the extract from the loss in mass of the segments and the volume of the extract.

To produce the flux test solution, adjust the non-volatile matter content of the extract to 25 % by mass, by evaporation or by dilution with the solvent used during the extraction stage.

7.1.4 Solder paste samples

Use solder paste samples, as received (i.e. unmodified), as the solder paste test material.

7.1.5 Paste flux samples

Use paste flux samples, as received (i.e. unmodified), as the paste flux test material.

7.2 Preparation of the test coupons

7.2.1 Sample identification

Following inspection, in accordance with Clause 6, mark test coupons using a positive, permanent and non-contaminating method, e.g. with an engraving tool, so that they can be identified.

7.2.2 Test coupons

The preparation and number of test coupons shall be in accordance with Table 1, and is dependent on the sample group. Include a minimum of two control coupons for each test run in each test chamber.

Each test coupon shall comprise four test patterns with the following dimensions.

— Width: 0,4 mm (0,016 in);

— Overlap: 15,25 mm (0,6 in);

— 34 overlapping spaces;

— 1 040 squares (nominal).

Spaces shall be determined by counting the number of overlapping areas per pattern. Squares shall be determined by the following equation:

$$\frac{\text{length of overlap} \times \text{number of spaces}}{\text{spacing width}} \approx 1\,040 \text{ squares}$$

For Group A prepare a minimum of 12 test patterns for each liquid flux, paste flux, solid flux, flux cored solder wire and flux cored preform to be tested in the cleaned state. If more than 12 test patterns are used, report all results.

When testing fluxes which are intended to remain in the uncleaned state use 24 test patterns. Wave solder 12 uncleaned test patterns, pattern side down (Group B of Table 1) and 12 test patterns, pattern side up (Group C of Table 1).

Reflow solder paste coupons pattern side up and either clean (Group D of Table 1) or not (Group E of Table 1), depending on the intended usage of the flux.

Pre-clean Group F coupons (see 7.2.3) but neither flux, solder or post-solder clean.

NOTE Preconditioning of SIR test coupons (see 8.1.2) may be used to determine initial coupon cleanliness levels.

Table 1 — Minimum number of patterns for SIR test

Sample group	Flux/solder	Clean	Number of test patterns
A	Yes	Yes	12
B	Yes	No	12
C	Yes	No	12
D	Yes	Yes	12
E	Yes	No	12
F	No	No	8

A = Pattern down/clean

B = Pattern down/no clean

C = Pattern up/no clean

D = Solder paste/reflow/clean

E = Solder paste/reflow/no clean

F = Control (pre-cleaned, unprocessed)

7.2.3 Test coupon pre-cleaning

Pre-clean the test coupons using one of the following methods.

a) Gently brush under deionized water using a soft brush (5.10), for 30 s. Rinse the coupons in the deionized water and then in propan-2-ol (4.1) and air dry.

b) Place the test coupons in an ionic contamination tester containing one of the following test solutions:

   1) a volume fraction of 75 % propan-2-ol, 25 % deionized water solution or

   2) a volume fraction of 50 % propan-2-ol, 50 % deionized water solution.

Process until ionic residue is less than 0,1 µg/cm^2 NaCl equivalent.

8 Procedure

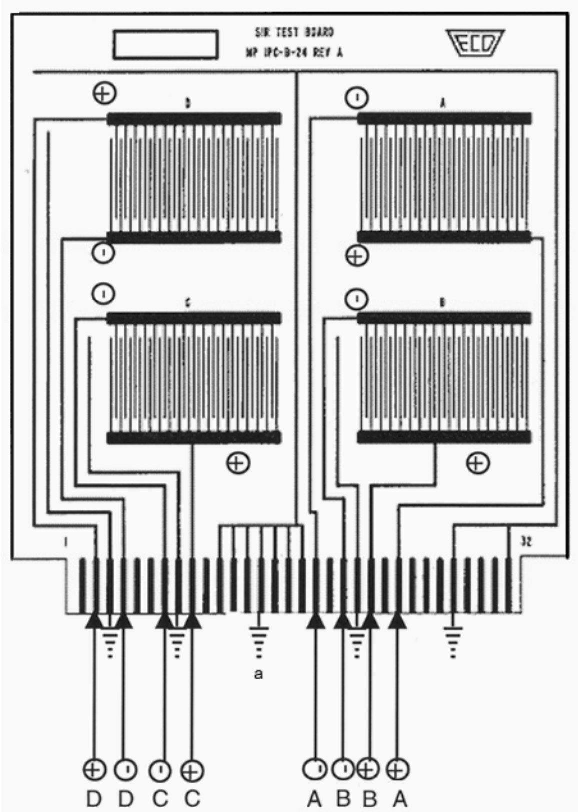
8.1 Methods for connecting test coupons

8.1.1 Board circuitry layout

8.1.1.1 Methods of connection

Connect the test coupons as shown on Figure 5 and by either hardwiring, in accordance with 8.1.1.2 or by connector interfacing, in accordance with 8.1.1.3.

NOTE See A.7 for guidance on the advantages and disadvantages of using connectors as part of the measurement system.



a Earth

Figure 5 — IPC-B-24 coupon connections

8.1.1.2 Hard wiring

For each test coupon (5.5), first cover the patterns to be tested with aluminium foil to protect them from contamination during interconnect attachment soldering.

NOTE The aluminium foil should be configured to tent the patterns, but not to touch them.

Solder a suitably insulated wire (5.3) to the appropriate coupon tab (see Figure 4) using a soldering iron (5.6.5) and flux-cored solder wire (5.6.1). Use a minimum amount of solder to make each joint and do not allow solder or flux to contaminate the test pattern. Tag each wire so that it can be identified outside the humidity chamber.

8.1.1.3 Connector interfacing

When connectors are used, slide coupon edge pads into the connector, mating the gold coupon tabs to the corresponding gold finish connector tabs.

NOTE Some users may use fixtures with gold plated pins to interconnect with the gold coupon tabs. In such cases the same requirements would apply.

8.1.2 Preconditioning of SIR test coupons prior to processing (optional)

NOTE 1 This option is intended for users who wish to verify the cleanliness (in terms of SIR) of the test coupons prior to fluxing and soldering.

Connect the coupons (see 8.1.1.1).

Precondition coupons for a period of 8 h to 16 h in the humidity chamber (5.7), programmed for the appropriate test condition, as follows:

a) 40 °C with a relative humidity 93 % (in accordance with IEC 60068-2-20);

b) 85 °C with a relative humidity 85 %.

NOTE 2 See A.1 for guidance on which test condition should be used. See A.2 and A.3 for information on specimen integrity during testing.

Take SIR measurements (see 8.4) at the end of the preconditioning period at the test conditions.

NOTE 3 See A.4 for information about frequency of monitoring during SIR testing.

8.2 Fluxing and soldering test patterns

8.2.1 Liquid and solid flux samples and flux-cored solder wire samples

Protect edge connector tabs from flux and solder contamination on all coupons. Solder test patterns, listed in Table 1, circuit side down in accordance with 8.2.2 or 8.2.3.

Do not flux or solder the control test patterns.

If the flux residues are not designed to be cleaned during production (see 7.2.2), process a second set of test patterns circuit side up.

After soldering, examine the test patterns to ensure there are no short circuits. Discard data from any test patterns exhibiting short circuits. Add additional coupons to maintain the number of required test patterns specified in Table 1.

8.2.2 Soldering using wave solder system

Liberally apply the flux test solution obtained in 7.1.1, 7.1.2 or 7.1.3, as appropriate, to the pattern side of the test coupons (5.5), ensuring that the test patterns are coated. Wave solder using a solder schedule which achieves topside preheat temperature as recommended by the flux manufacturer and a dwell time in the solder pot of 3 s ± 1 s at a solder temperature of between 245 °C and 260 °C.

8.2.3 Soldering using static solder pot

Liberally apply the flux test solution obtained in 7.1.1, 7.1.2 or 7.1.3, as appropriate, to the pattern side of the test coupons (5.5), ensuring that all the patterns are coated. Allow the excess flux to drain off by standing the coupons vertically on absorbent paper for 10 s. Dry the coupons for 5 min in the drying oven (5.2), maintained at (100 ± 3) °C.

Solder by floating the test coupon on a static solder pot maintained between 245 °C and 260 °C with a dwell time in the solder pot of 4 s ± 1 s.

8.2.4 Solder paste samples

Referring to 7.2.2, select the appropriate sample size using a nominal 150 µm thick stencil, with the solder paste sample such that 100 % of the track is covered with solder. The aperture shall be at least 80 % of the line width of the test pattern.

NOTE 1 The control coupon is not printed with the solder paste.

NOTE 2 For pastes with powder particles less than 38 µm, a 100 µm thick stencil should be used.

Solder the test coupons using a reflow solder oven (5.6.4) using the temperature profile recommended by the flux manufacturer.

After soldering, examine the test patterns to ensure there are no short circuits. Discard data from any test patterns exhibiting short circuits. Add additional coupons to maintain the number of test patterns specified in Table 1.

8.2.5 Paste flux samples

8.2.5.1 Referring to 7.2.2, select the appropriate sample size. Using a clean scalpel (5.11) apply a layer of paste flux over the entire area of each test pattern used 70 µm ± 20 µm thick. Solder in accordance with 8.2.5.2 or 8.2.5.3.

NOTE A layer of flux of the desired thickness may be doctor-bladed (see 5.11) on to the coupon by placing two-strips of plastic sheet of the correct thickness on either side of the pattern areas and, using a long, flat metal edge or squeegee, printing the flux on to the test patterns.

8.2.5.2 Wave solder (see 5.6.2) using a solder schedule which achieves topside preheat temperature as recommended by the flux manufacturer and a dwell time in the solder pot of between 2 s and 4 s at a solder temperature of between 245 °C and 260 °C.

8.2.5.3 Float the test coupon on a static solder bath maintained between 245 °C and 260 °C with a dwell time in the solder pot of between 3 s and 5 s.

8.3 Cleaning

For fluxes requiring cleaning after soldering, clean the test coupons using the cleaning media and method recommended by the flux manufacturer as being suitable for the removal of post-soldering flux residues. Include details of the cleaning procedure used on the coupons in the test report (see Clause 11).

Do not subject control coupons to this cleaning process.

Do not clean the coupons when testing fluxes intended for use on applications where the flux residues will not be cleaned after soldering.

8.4 SIR measurement

8.4.1 High resistance measurement system verification

Prior to connecting test coupons to the measurement system, connect each cable assembly to the resistor verification coupon (5.9) inside the humidity chamber at ambient conditions and take a measurement. Rework and replace any cable that does not read within the tolerance value of the total measurement system (± 5 % up to 10^{10} Ω, ± 10 % between 10^{10} Ω and 10^{11} Ω, and ± 20 % above 10^{11} Ω.

NOTE See A.5 for information about electromagnetic shielding of cables and A.6 for further information about connecting the verification coupon.

8.4.2 Test coupon measurements

After connecting coupons in accordance with 8.1.1.1 select environmental conditions a) or b), as appropriate.

a) 40 °C with a relative humidity 93 % (in accordance with IEC 60068-2-20);

b) 85 °C with a relative humidity 85 %.

NOTE 1 See A.1 for guidance on which environmental conditions should be used and A.2 and A.3 for information on specimen integrity during testing.

Insert test coupons into the humidity chamber (5.7). Without bias applied, stabilize chamber at 25 °C and 50 % RH for 2 h and take an initial SIR measurement. Ramp chamber up to test conditions by first ramping up temperature and then humidity to prevent condensation on test samples.

NOTE 2 This ramp-up should not exceed 3 h.

Duration of testing shall be a minimum of 168 h at test conditions. Apply bias 1 h after chamber stabilization at test conditions. With the test coupons still in the humidity chamber, apply 50 V dc bias potential to each specimen. After bias application, take SIR measurements, as a minimum, twice a day at least 6 h apart at the same voltage and polarity.

NOTE 3 See A.4 for further information on the frequency of monitoring.

At the end of the test exposure, remove electrical bias from all test patterns, prior to temperature-humidity ramp-down initiation. After ramp-down, stabilize chamber at 25 °C and 50 % RH for 2 h and take a final SIR measurement.

8.5 Electrochemical migration test

8.5.1 High resistance measurement system verification

Prior to connecting test coupons to the measurement system, connect each cable assembly to the resistor verification coupon (5.9) inside the humidity chamber at ambient conditions and take a measurement. Rework and replace any cable that does not read within the tolerance value of the total measurement system (± 5 % up to 10^{10} Ω, ± 10 % between 10^{10} Ω and 10^{11} Ω, and ± 20 % above 10^{11} Ω).

NOTE See A.5 for information about electromagnetic shielding of cables and A.6 for further information about connecting the verification coupon.

8.5.2 Test coupon measurements

After connecting coupons in accordance with 8.1.1.1 select environmental conditions a) or b), as appropriate.

a) 40 °C with a relative humidity 93 % (in accordance with IEC 60068-2-20);

b) 85 °C with a relative humidity 85 %.

NOTE 1 See A.1 for guidance on which environmental conditions should be used and A.2 and A.3 for information on specimen integrity during testing.

Insert test coupons into the humidity chamber (5.7). Without bias applied, stabilize chamber at 25 °C and 50 % RH for 2 h and take an initial SIR measurement. Ramp chamber up to test conditions by first ramping up temperature and then humidity to prevent condensation on test samples.

NOTE 2 This ramp-up should not exceed 3 h.

Duration of testing shall be 21 d at test conditions. Apply bias 1 h after chamber stabilization at test conditions. With the test coupons still in the humidity chamber, apply 50 V dc bias potential to each specimen.

At the end of the test exposure, remove electrical bias from all test patterns, prior to temperature-humidity ramp-down initiation. After ramp-down, stabilize chamber at 25 °C and 50 % RH for 2 h and take a final SIR measurement.

9 Assessment

All samples shall be visually inspected at 10 × to 30 ×, within 24 h of test completion and the following conditions recorded:

a) Presence of dendrites; if present, percentage spacing between conductors bridged by the worst-case dendrite shall be recorded.

b) Presence of discoloration between conductors (discoloration on conductors only is acceptable); if present, discoloration shall be recorded as a colour image and included in the test report.

c) Presence of water spots; if present these conditions shall be recorded as a colour image and included in the test report.

d) Presence of subsurface filament formation. When examined with backlighting, the presence of subsurface filament formation is shown by a dark subsurface “shadow” growing from the anode; if present these conditions shall be recorded as a colour image and included in the test report.

If the resistance measurements taken on the control samples fall below 1 000 MΩ and the coupons with the candidate material(s) fail, a new set of test coupons shall be prepared and the test repeated.

Any reason for deleting values (scratches, condensation, solder bridged conductors, outlying points, etc.) shall be noted. If, for a given condition, the results for more than two test patterns are rejected then the test shall be repeated.

10 Precision

An intra-laboratory test equipment assessment shall be performed on all SIR test coupons prior to the execution of the SIR testing to verify that the repeatability of the test coupon is within the acceptable limits. The analysis shall measure the repeatability using the gauge r and R methodology specified in ISO 5725-2.

The repeatability assessment shall consist of a minimum of five repeated measurements on a minimum of 12 test patterns.

The results shall report the standard deviation, repeatability, r, and the repeatability percentage of the specification for each of the test values being captured. The repeatability percentage shall be no greater than 10 % of the specification range.

11 Test report

The test report shall include, at least, the following information:

a) identification and preparation of the flux sample (see 7.1);

b) reference to this part of ISO 9455, i.e. ISO 9455-17;

c) details of any post-soldering cleaning procedures used before coupon conditioning and measurement (see 8.3);

d) details of the solvent used for the solid flux sample, if appropriate (see 7.1.2);

e) qualification test report;

NOTE The qualification test report should be in accordance with Annex B.

f) individual charts or graphs showing the measured resistance (log ohms vs. time) for each coupon and test pattern, or box plots for the data set;

g) SIR results obtained for each pattern:

  1) after optional preconditioning, if applicable (see 8.1.2);

  2) initial, at ambient conditions (see 8.4.2);

3) twice daily readings, at least 6 h apart (see 8.4.2);

4) final, at 25 °C and 50 % RH (see 8.4.2);

h) any unusual features noted during the test;

i) details of any operation not included in this part of ISO 9455, or regarded as optional;

j) the environmental conditions used for the test, i.e. condition a) or b) in 8.4.2.

Annex A
(informative)

SIR testing guidance

A.1 Test conditions

Fluxes that contain more than 1 % by weight organic acid activators, such as adipic acid, that volatilize significantly at 85 °C, and less than 5 % by weight rosin or modified-rosin resin should be tested at 40 °C and 93 % RH. Fluxes that contain more than 0,1 % by weight ionic halide should be tested at 85 °C and 85 % RH.

CAUTION — Some weak organic acid-containing fluxes have volatile residues which may be driven off at the higher test temperatures than those experienced in environmental conditions.

A.2 Risk of condensation

If condensation occurs on the test coupons in the environmental chamber while the coupons are under voltage, dendritic growth or filament formation can occur. Dendritic growth or filament formation can be caused by a lack of sufficient control of the humidification of the oven. Water spotting may also be observed in some ovens where the air flow in the chamber is from back to front. In this case, water condensation on the cooler oven window can be blown around the oven as micro-droplets which deposit on the test coupon surfaces and cause dendritic growth if the spots bridge the distance between electrified conductors. Both of these conditions must be eliminated for proper testing.

A.3 Precautions

It is recommended that a drip shield be placed over and/or around the test samples to prevent water droplets from dropping from the chamber ceiling or from the chamber doors on to the energized test samples. However, the drip shield should also not interfere with good air flow around the test samples, which may require innovative shielding approaches.

A.4 Frequency of monitoring

During SIR testing resistance values can change rapidly over a period of minutes. These are often transitory in nature with SIR values often recovering by the end of the test. Such a drop in SIR may constitute failure in real product. Modern frequent sampling instruments can monitor up to 128 SIR patterns in less than 20 min, and so capture this type of short lived events. It is recommended that measurement readings be taken as frequently as possible to detect rapid changes in SIR.

A.5 Electromagnetic shielding

For consistent and repeatable results, it is important that all cabling carrying test signals be encased in an electromagnetic shield. Most often, this is a metallic foil or braid material. Since SIR measurement often deals with picoamperes of current or less, electromagnetic coupling (EMC) and other stray electrical fields can unduly affect the test signals. Encasing the signal lines with an earthed metal dramatically reduces currents due to EMC and other electrical noise. It is not necessary to individually shield each line, such as in coaxial cabling, but separating voltage supply lines and current-return lines is recommended. A single EMC shield can be used to encase all current-return lines.

A.6 Connections

During the actual execution of the test programme, the verification coupon should be connected to the high resistance measurement system via an external connector or connection. The test coupon can then be periodically measured to verify that the high resistance measurement system is under proper operating conditions should anomalous readings be observed.

A.7 Advantages and disadvantages of using connectors as part of the measurement system

A.7.1 Advantages

a) Ease of use. Preparation for an SIR test is fairly easy; simply plug the coupon into the edge card connector.

b) Connector assemblies can be made in higher volumes during slack time.

c) No hand soldering is done, therefore, no additional flux residues will contact the test patterns.

d) Handling is kept to a minimum.

e) The orientation of the best coupon can be held parallel to the chamber air flow.

A.7.2 Disadvantages

a) Depending on the materials of construction, the connectors may have leakage currents resulting in a 0,5 decade drop (or higher) at 10^{12} Ω compared to hard wired samples. Proper connector design and choice of highly insulating materials (e.g. PTFE) can minimize this effect.

b) The connectors should be verified before each use and monitored with time to determine if the resin system has aged, resulting in greater leakage currents.

c) The spring loaded contacts will wear with each use. Solder bulges on the test coupons increase the wear. Examining the contact fingers on test coupons as coupons are withdrawn from the test can give an indication of adequate contact (look for scratches).

d) The cover metallization on the spring loaded contacts will wear, especially if soft gold. This wear can result in dissimilar metals in contact and an increase in contact resistance.

e) Potential for entrapment of moisture.

Annex B
(informative)

Surface insulation resistance comb test and electrochemical migration test of flux residues — Qualification test report

Overall assessment

Material identification

ID Number:	
Flux classification (flux type):	
Flux form[a]:	
Manufacturer's identity:	
Manufacturer's batch number:	
Date of manufacturer:	
Original use by date:	
Solder alloy (if used):	
[a] Refers to: liquid, paste, cored wire, preform, etc.	

Processing parameters

Reflow method:	
Maximum preheat temperature (°C):	
Time above liquidus or solder contact time:	
Cleaning method, materials and parameters:	

Testing parameters

Date original qualification tests complete:	
Tested by:	
Interconnect attachment method[a]:	
Chamber within stated tolerances?	
Test anomalies noted:	
Number of patterns tested:	
Number and identity of reworked patterns:	
Preconditioning time:	
Test environment:	
[a] Refers to method used to interconnect coupons: hard wire solder vs. connectors or dedicated fixtures.	

Visual examination

Parameter	Observations
Dendritic growth?	
Corrosion?	
Other visual effects:	

Material identification number: _____________

Summary: measurement result

All measurement values are listed in log ohms (base 10 logarithm of the measured resistance).

Requirements: no value may fall under 100 megohms (8,0 log ohms) at any time during the test.

Control Coupons

	SIR measurements (log ohms)															
Parameter	**Initial**[a]	**D1A**[b]	**D1B**	**D2A**	**D2B**	**D3A**	**D3B**	**D4A**	**D4B**	**D5A**	**D5B**	**D6A**	**D6B**	**D7A**	**D7B**	**Final**[a]
Geometric mean																
No. of patterns in mean																
Minimum reading																
Number of readings below requirement																
Maximum reading																
Standard deviation (σ)																

Qualification test report *(continued)*

Candidate Flux Material Coupons

	SIR measurements (log ohms)															
Parameter	**Initial**[a]	**D1A**[b]	**D1B**	**D2A**	**D2B**	**D3A**	**D3B**	**D4A**	**D4B**	**D5A**	**D5B**	**D6A**	**D6B**	**D7A**	**D7B**	**Final**[a]
Geometric mean																
No. of patterns in mean																
Minimum reading																
Number of readings below requirement																
Maximum reading																
Standard deviation (σ)																

Deleted patterns (if applicable)

Pattern deleted	Reason for deletion

[a] Initial and final values are made at ambient conditions (25 °C and 50 % RH). All other values are taken at elevated conditions (40 °C and 93 % RH or 85 °C and 85 % RH).

[b] D1A refers to Day 1, first reading. D1B refers to Day 1, second reading (if taken), etc.

NOTE Individual charts/graphs showing the measured resistance in log ohms vs. time for each coupon and test pattern, or box plots for the data set are required to be attached to this qualification report.

Bibliography

[1] ISO 9454-1:1990, *Soft soldering fluxes — Classification and requirements — Part 1: Classification, labelling and packaging*

[2] IPC 9201, *The Surface Insulation Resistance Handbook*, published July 1996, IPC, 2215, Sanders Road, Northbrook, IL, 60062-6135, USA

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