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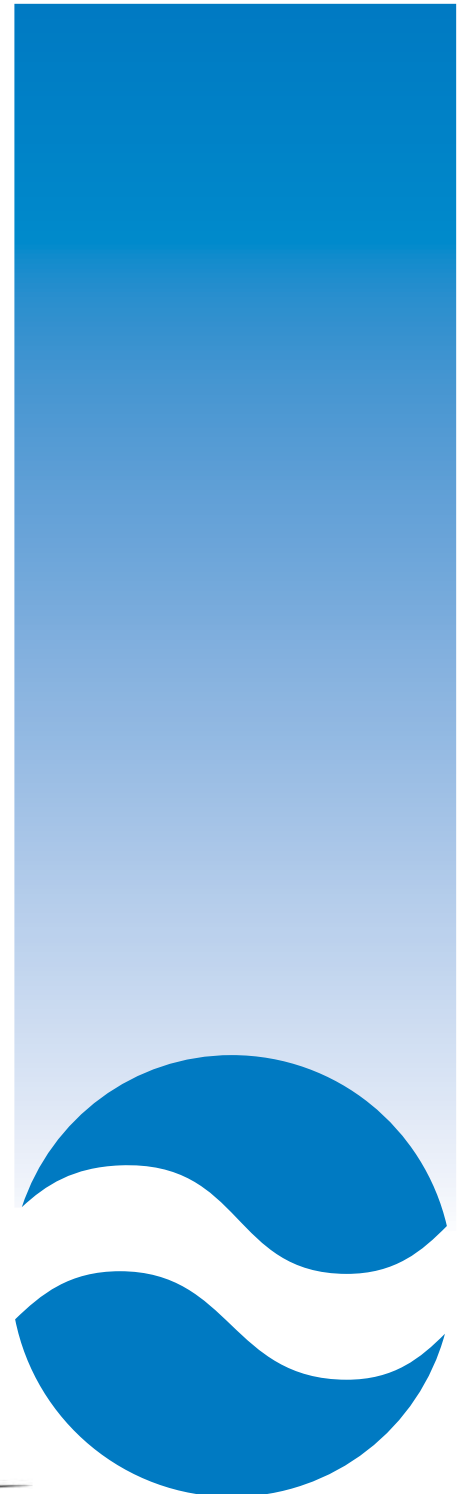
June 2013

JOINT INDUSTRY STANDARD

Solderability Tests for
Component Leads,
Terminations, Lugs,
Terminals and Wires



Electronic Components Industry Association



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EIA/IPC/JEDEC J-STD-002E

Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires

A joint standard developed by IPC Component and Wire Solderability Specification Task Group (5-23b) of the Assembly and Joining Processes Committee (5-20), the Electronic Components Industry Association Soldering Technology Committee (STC) and the JEDEC Solid State Technology Association Committee (JC14.1)

Users of this publication are encouraged to participate in the development of future revisions.

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Solderability Tests for Component Leads, Terminations, Lugs, Terminals and Wires

1 PREFACE

1.1 Scope This standard prescribes test methods, defect definitions, acceptance criteria, and illustrations for assessing the solderability of electronic component leads, terminations, solid wires, stranded wires, lugs, and tabs. This standard also includes a test method for the resistance to dissolution/dewetting of metallization. This standard is intended for use by both supplier and user.

1.2 Purpose Solderability evaluations are made to verify that the solderability of component leads and terminations meets the requirements established in this standard and to determine that storage has had no adverse effect on the ability to solder components to an interconnecting substrate. Determination of solderability can be made at the time of manufacture, at receipt of the components by the user, or just before assembly and soldering.

The resistance to dissolution of metallization determination is made to verify that metallized terminations will remain intact throughout the assembly soldering processes.

In the case of a discrepancy, the description or written criteria always takes precedence over the illustrations.

1.2.1 Shall and Should The words “shall” or “shall not” are used in the text of this document wherever there is a requirement for materials, preparation, process control, or acceptance of a soldered connection or a test method. The word “should” reflects recommendations and is used to reflect general industry practices and procedures for guidance only.

1.2.2 Document Hierarchy In the event of conflict, the following decreasing order of precedence applies:

1. Procurement as agreed between user and supplier.
2. Master drawing or master assembly drawing reflecting the user’s detailed requirements.
3. When invoked by the user or per contractual agreement, this document, J-STD-002.
4. Other documents to the extent specified by the user/customer.

1.3 Method Classification This standard describes methods by which component leads or terminations may be evaluated for solderability. Any one of the following test methods - Test A, Test B, Test C, Test D, and Test S - may be used for SnPb solder processes and any one of the following test methods - Test A1, Test B1, Test C1, Test D, and Test S1 - may be used for Pb-free solder processes and are to be used for each application as a default unless otherwise AABUS.

1.3.1 Visual Acceptance Criteria Tests

Test A – Solder Bath/Dip and Look Test (Leaded Components and Stranded Wires) SnPb Solder (4.2.1)

Test B – Solder Bath/Dip and Look Test (Leadless Components) SnPb Solder (4.2.2)

Test C – Wrapped Wires Test (Lugs, Tabs, Hooked Leads, and Turrets) SnPb Solder (4.2.3)

Test D – Resistance to Dissolution/Dewetting of Metallization Test SnPb Solder and Pb-free Solder (4.2.4)

Test S – Surface Mount Process Simulation Test SnPb Solder (4.2.5)

Test A1 – Solder Bath/Dip and Look Test (Leaded Components and Stranded Wires) Pb-free Solder (4.2.6)

Test B1 – Solder Bath/Dip and Look Test (Leadless Components) Pb-free Solder (4.2.7)

Test C1 – Wrapped Wires Test (Lugs, Tabs, Hooked Leads, and Turrets) Pb-free Solder (4.2.8)

Test S1 – Surface Mount Process Simulation Test Pb-free Solder (4.2.9)

1.3.2 Force Measurement Tests

Test E – Wetting Balance Solder Pot Test (Leaded Components) SnPb Solder (4.3.1)

Test F – Wetting Balance Solder Pot Test (Leadless Components) SnPb Solder (4.3.2)

Test G – Wetting Balance Globule Test SnPb Solder (4.3.3)

Test E1 – Wetting Balance Solder Pot Test (Leaded Components) Pb-free Solder (4.3.4)

Test F1 – Wetting Balance Solder Pot Test (Leadless Components) Pb-free Solder (4.3.5)

Test G1 – Wetting Balance Globule Test Pb-free Solder (4.3.6)

These methods (1.3.2) are included for evaluation purposes only. Data collected should be submitted to the IPC Wetting Balance Task Group for correlation and analysis. Tests E, F, G, E1, F1 and G1 **shall not** be used for acceptance/rejection without user and supplier agreement.

1.4 Coating Durability The following are guidelines, not specification requirements, for determining the needed level of preconditioning category assurance (see Table 3-3). The coating durability guidelines describe two broad usage sectors and are not intended to encompass all possible product use scenarios. The user and supplier need to agree on the coating durability requirements. Coating Durability Category 2 is the default condition for all component finishes.

Category 1 – Minimum Coating Durability Intended for surfaces that will be soldered within a short period of time (e.g., up to six months) from the time of testing and are likely to experience a minimum of thermal exposures before soldering. No preconditioning category per Table 3-3.

Category 2 – Typical Coating Durability Intended for surfaces whose solderability may become degraded from storage of longer than six months or from multiple thermal exposures. This is preconditioning Category E per Table 3-3.

1.5 Solderability Backwards Compatibility Typically Pb containing terminations are evaluated using SnPb solderability test conditions and Pb-free terminations use Pb-free test conditions. If Pb-free terminations are to be used in a SnPb solder process (backward compatibility) then they should be evaluated at 215 °C using test parameters consistent with standard SnPb solder conditions. The backward compatibility test does not apply to Pb-free BGA type packages.

1.6 Referee Verification Solder Dip for Tests A, B, C, A1, B1, and C1 When the dipped portion of the termination exhibits anomalies such as surface roughness, dross, or anomalies that may have been induced by improper solder dipping, a referee verification solder dip of the suspect anomaly may be necessary. Upon reinspection, if the suspect anomaly has been removed, the anomaly will have been verified as a non-rejectable cosmetic surface defect. If the anomaly persists, regardless of area it **shall** be classified a rejectable solderability defect. This procedure may only be used on one component per lot. Continuous need of Referee Verification Solder Dip procedure is an indication of either improper testing procedure, examination interpretation, or of poor component quality.

1.7 Limitations This standard **shall not** be construed as a production procedure for the pre-tinning of leads and terminations. Solderability testing of components is considered a destructive test and the tested component should not be used for functional electrical evaluation. Components after such solderability testing **shall** only be used AABUS.

1.8 Contractual Agreement In cases where the stated test parameters are inappropriate or insufficient, alternative parameters may be AABUS.

1.9 Terms and Definitions Terms repeated from IPC-T-50 are indicated by an asterisk (*).

AABUS Abbreviation for “as agreed by user and supplier.”

Dewetting* A condition that results when molten solder coats a surface and then recedes to leave irregularly-shaped mounds of solder that are separated by areas that are covered with a thin film of solder and with the basis metal not exposed.

Dissolution of Component Metallization (Leaching) The loss or removal of metallization from an area on the basis or substrate material after immersion in molten solder.

Equilibrium Wetting The degree of wetting in which the forces of wetting are in balance with the forces of gravity.

Nonwetting, Solder* The inability of molten solder to form a metallic bond with the basis metal.

Pinhole* An imperfection in the form of a small hole that penetrates through a layer of material.

Solderability* The ability of a metal to be wetted by molten solder.

Solder Connection Pinhole* A small hole that penetrates from the surface of a solder connection to a void of indeterminate size within the solder connection.

Supplier* The entity that provides a service or product to the user. Term should be used in lieu of vendor.

User* The entity that receives a service or product from the supplier. Term can be used in lieu of customer.

Wetting, Solder* The formation of a relatively uniform, smooth, unbroken, and adherent film of solder to a base metal.

2 APPLICABLE DOCUMENTS

The following documents of the issue currently in effect form a part of this standard to the extent specified herein.

2.1 Industry

2.1.1 IPC¹

IPC-T-50 Terms and Definitions

J-STD-004 Requirements for Soldering Fluxes

J-STD-005 Requirements for Soldering Pastes

J-STD-006 Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solder for Electronic Soldering Applications

IPC-TR-464 Accelerated Aging for Solderability Evaluations and Addendum

IPC-TM-650 Test Methods Manual²

2.1.2 International Electrotechnical Commission³

IEC 60068-2-69 Environmental testing - Part 2-69: Tests - Test Te: Solderability testing of electronic components for surface mounting devices (SMD) by the wetting balance method

2.2 Government⁴

2.2.1 Federal⁵

(CID) A-A-59551 Wires, Electrical, Copper (Uninsulated)

3 REQUIREMENTS

3.1 Materials All chemicals **shall** be of commercial grade or better. Fresh solvents **shall** be used as often as is necessary to preclude contamination.

3.1.1 Solder For SnPb testing, the solder composition **shall** be Sn60Pb40 or Sn63Pb37 per J-STD-006. The composition of the solder, including contamination levels, **shall** be maintained during testing per 3.4.1.

For Pb-free testing, the solder composition **shall** be Sn96.5Ag3.0Cu0.5 (SAC305), allowing variation of the Ag content between 3.0-4.0 wt% and Cu content between 0.5-1.0 wt% with the balance being Sn per J-STD-006. If no Pb-free solder alloy is specified, the default solder composition **shall** be Sn96.5Ag3.0Cu0.5 (SAC305) per J-STD-006. Other Pb-free solder alloys may be used AABUS.

The composition of the SnPb solder paste to be used in Test S **shall** be Sn60Pb40 or Sn63Pb37 for SnPb per J-STD-005, flux type ROL1. The solder paste **shall** meet the storage and shelf life requirements of the manufacturer's specification.

The composition of the Pb-free solder paste to be used in Test S1 **shall** be Sn96.5Ag3.0Cu0.5 (SAC305), allowing variation of the Ag content between 3.0 - 4.0 wt% and Cu content between 0.5 - 1.0 wt% with the balance being Sn per J-STD-005. If no Pb-free solder paste is specified, the default composition **shall** be Sn96.5Ag3.0Cu0.5 (SAC305) per J-STD-005, flux type to be AABUS. Other Pb-free paste solder alloys may be used AABUS. The solder paste **shall** meet the storage and shelf life requirements of the manufacturer's specification.

1. www.ipc.org

2. Current and revised IPC Test Methods are available on the IPC Web site (www.ipc.org/html/testmethods.htm)

3. www.iec.ch

4. apps.fas.gsa.gov

5. <http://astimage.daps.dla.mil/quicksearch/>

3.1.2 Flux The flux for SnPb solderability tests **shall** be a standard activated rosin flux #1 having a composition of 25% $\pm$ 0.5% by weight of colophony and 0.15% $\pm$ 0.01% by weight diethylammonium hydrochloride (CAS 660-68-4), in 74.85% $\pm$ 0.5% by weight of isopropyl alcohol (see Table 3-1).

The flux for Pb-free solderability tests **shall** be standard activated rosin flux #2 having a composition of 25% $\pm$ 0.5% by weight of colophony and 0.39% $\pm$ 0.01% by weight diethylammonium hydrochloride (CAS 660-68-4), in 74.61% $\pm$ 0.5% by weight of isopropyl alcohol (see Table 3-1).

Table 3-1 Flux Compositions

Constituent	Composition by Weight Percent	
	Flux #1	Flux #2
Colophony	25 $\pm$ 0.5	25 $\pm$ 0.5
Diethylammonium Hydrochloride (CAS 660-68-4)	0.15 $\pm$ 0.01	0.39 $\pm$ 0.01
Isopropyl Alcohol (IPA) (CAS 67-63-0)	Balance	Balance
Weight of Chlorine as maximum % of Solids	0.2	0.5

Appendix E.2 provides possible flux product sources; this list is subject to change. Appendix F provides information about this flux.

The flux to be used in preparing the standard copper wrapping wires (see 3.1.3) for tests C and C1 **shall** be standard flux #2.

3.1.2.1 Flux Maintenance Standard activated rosin fluxes #1 and #2 **shall** be covered during breaks in testing (e.g., lunch) and discarded after eight hours.

3.1.3 Standard Copper Wrapping Wires The standard wrapping wires specified in 4.2.3.2 **shall** be fabricated from type S, soft or drawn and annealed, uncoated in accordance with (CID) A-A-59551 and prepared per the following process.

The nominal diameter of the wrapping wires **shall** be 0.6 mm [0.024 in]. The preparation of the wrapping wires **shall** be as follows:

- Straighten and cut wires into convenient lengths (50 mm [1.9 in] minimum).
- Degrease by immersion in an appropriate cleaner (e.g., isopropyl alcohol) for two minutes.
- Clean in fluoroboric acid 10% HBF₄ (by volume), in water, for five minutes at room temperature with agitation. Use caution in handling.
- Rinse acid off as follows:
 - Two non-heated water rinses (deionized or distilled).
 - Two isopropyl alcohol rinses.
 - Air dry.
- Immerse in standard flux #2.
- Dip in molten solder for five seconds at 245 $\pm$ 5 °C [473 $\pm$ 9 °F] for SnPb solder alloy. Dip in molten solder for five seconds at 255 $\pm$ 5 °C [491 $\pm$ 9 °F] for Pb-free solder alloy.
- Remove all visible flux residues.

Standard wrapping wires will be stored in a clean, covered container if not used immediately. The usable life of the standard wrapping wires **shall not** exceed 30 days after coating.

3.1.4 Water The water to be used for steam conditioning purposes **shall** be distilled or deionized.

3.2 Equipment The following equipment applies to more than one of the solderability test methods shown in this standard. Equipment that is specific to any of the test methods is described in the specific section 4 paragraphs detailing the method.

3.2.1 Steam Preconditioning Apparatus The steam conditioning chamber **shall** be constructed of non-corrodible materials such as borosilicate glass, quartz glass, stainless steel, or PTFE. The specimen holder **shall** be non-reactive to prevent galvanic corrosion. The container should be insulated. The steam temperature at the conditioning level **shall** be maintained per the requirements of Table 3-2.

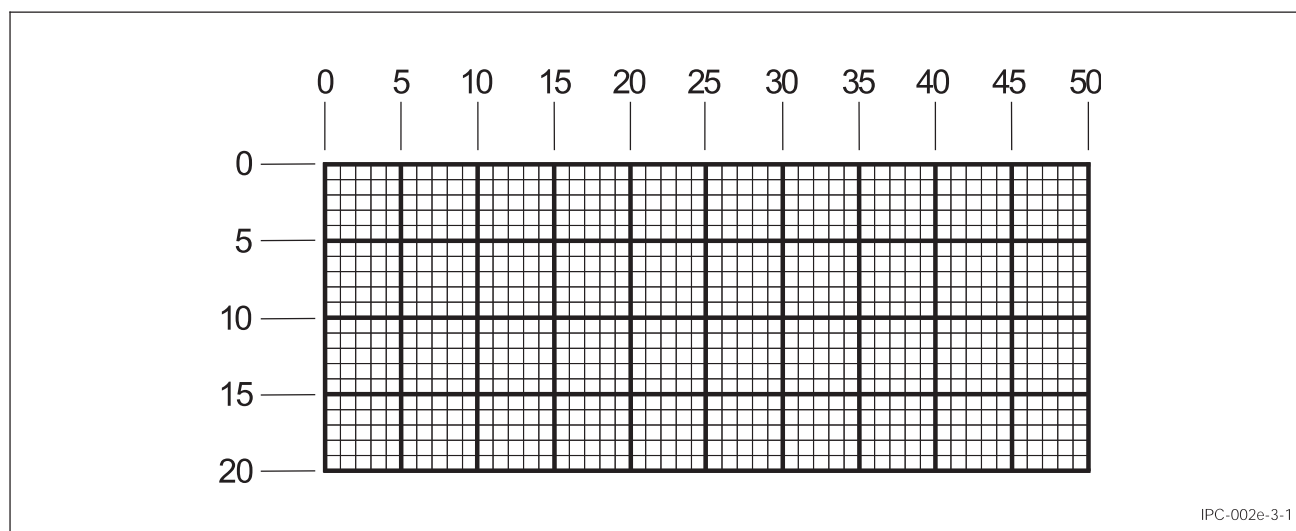
Table 3-2 Steam Temperature Requirements

Altitude	Average Local Boiling Point °C	Steam Temperature Limits °C
0-305 m	100	93 ± 3
305-610 m	99	92 ± 3
610-914 m	98	91 ± 3
914-1219 m	97	90 ± 3
1219-1524 m	96	89 ± 3
1524-1829 m	95	88 ± 3

A safe means to prevent excessive pressure and a means of maintaining adequate water level **shall** be provided. Neither **shall** cause the vapor to cool below the specified temperature. Condensate **shall** drip freely back to the water. Care should be taken to minimize contact between the condensate and the specimens.

3.2.2 Bake Preconditioning Apparatus A bake oven of sufficient size and capable of continuously maintaining $155\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$ [$311\text{ }^{\circ}\text{F} \pm 9\text{ }^{\circ}\text{F}$] temperature control **shall** be used. If the bake oven is used for the curing of adhesives, due diligence **shall** be conducted to insure cross contamination of the test specimens **shall not** occur.

3.2.3 Optical Inspection Equipment All test methods requiring visual inspection **shall** use microscope(s) capable of 10X magnification (see individual test methods), equipped with reticles, or equivalent, for measurement. An example of a reticle is shown in Figure 3-1. Shadowless lighting (i.e., uniform, nonglare, nondirectional) **shall** be suitable for proper inspection.

**Figure 3-1 Example Reticle**

3.2.3.1 Referee Magnification Referee magnification **shall** be 30X. For fine pitch leaded parts (0.5 mm [0.020 in] pitch or less) the referee magnification **shall** be 70X. Referee conditions **shall** only be used to accept a product that has been rejected at the inspection magnification.

3.2.4 Dipping Equipment Solder dipping devices **shall** be mechanical/electromechanical and capable of controlling the immersion (rates), dwell time and immersion depth as specified in 4.2.1 to 4.2.9. Sample holding fixtures **shall** be designed to avoid trapping any excess flux in the fixture and to minimize heat loss and assure reproducibility of test results.

3.2.5 Timing Equipment Timing equipment **shall** be automated, where applicable, and accurate to the limits of the test method.

3.3 Preparation for Testing

3.3.1 Specimen Preparation and Surface Condition All component leads or terminations **shall** be tested in the condition that they would normally be in at the time of assembly soldering. The specimen surfaces to be tested **shall** be handled in such a manner as to not cause contamination, nor **shall** the leads or terminations being tested be wiped, cleaned, scraped, or abraded.

Special preparation of leads or terminations, such as bending, **shall** be specified in the applicable procurement document. Lead orientation for testing is specified in each test method. If the insulation on stranded wire must be removed, it **shall** be done in a manner so as not to loosen or damage the individual strands of the wires.

3.3.1.1 Preconditioning Categories The user **shall** specify to the supplier, as part of the purchase agreement, the required coating durability (see 1.4) and Preconditioning Category per Table 3-3 with Preconditioning Category E (155 °C Dry Bake) as the default condition, if not specified in the purchase agreement.

Table 3-3 Preconditioning Parameters for Solderability Testing

Condition Category	Precondition Type	Exposure Parameters	Use Recommendation	Applicability by Finish
A	Steam	1 Hour $\pm$ 5 min.	Optional Legacy	Non-Tin and Non-Tin Alloy Containing Finishes
B		4 Hours $\pm$ 10 min.	Optional Legacy	All Finishes
C		8 Hours $\pm$ 15 min.	Optional Legacy	All Finishes
D		16 Hours $\pm$ 30 min.	Optional Legacy	All Finishes
E	155 °C Dry Bake	4 Hours $\pm$ 15 min.	Default Condition	All Finishes

3.3.2 Steam Conditioning Before the application of flux and subsequent solderability testing, all specimens designated Condition Category A thru D **shall** be conditioned in the device and under the conditions described in 3.3.1 at a steam temperature which is 7 °C [12.6 °F] below the local boiling point (see Table 3-2).

All components to be tested **shall** be placed into the steam conditioning chamber such that no specimens have their leads or terminations touching, and that condensation forming will drain away from the lead or terminations to the package body (e.g., “Dead Bug” for dual-inline packages).

Specimens **shall not** be stacked in a manner which restricts their surface exposure to steam nor **shall** they be placed closer than 10 mm [0.39 in] from the outer chamber walls, and **shall not** touch the inner container walls. In addition, no portion of the specimen **shall** be less than 40 mm [1.57 in] above the water level.

3.3.2.1 Post Steam Conditioning Drying After steam conditioning is complete, specimens **shall** be immediately removed from the chamber and dried using ambient air for 15 minutes minimum. Drying may be accomplished by baking at 100 °C [212 °F] maximum for 1 hour maximum in a dry nitrogen atmosphere AABUS. Solderability testing **shall** be performed within 72 hours of removal from the chamber.

3.3.2.2 Steam Equipment Maintenance Before use, the steam conditioning apparatus **shall** have been cleaned with deionized or distilled water or hydrogen peroxide to remove any accumulated residues. This cleaning should be accomplished within five working days of the conditioning period.

3.3.3 Surfaces to be Tested The critical areas of leads or terminations intended to be soldered **shall** be evaluated for solderability per the test method (see Appendix A). This **shall** include both the bottom termination and castellation on chip carriers and on all surfaces intended to be soldered on discrete devices. Through-hole leads that are tested by Method A **shall** have a 25 mm [0.98 in] portion, or the whole lead if less than 25 mm [0.98 in], evaluated for solderability (see 4.2.1.5).

Surfaces to be tested by Method D **shall** be completely immersed in molten solder during dipping (see 4.2.4).

3.4 Solder Bath Requirements

3.4.1 Solder Contamination Control The solder in solder baths used for solderability testing **shall** be chemically or spectrographically analyzed or replaced each 30 operating days. The levels of contamination and Sn content must be within those shown in Table 3-4. The intervals between analysis may be lengthened if the test results indicate that the contamination limits are not being approached. The composition of the Pb-free solder, including contamination levels, **shall** be maintained during testing with the silver and copper element levels adjusted for alloy requirements.

Note: An operating day consists of any eight-hour period, or any portion thereof, during which the solder is liquefied and used.

If contamination exceeds the limits specified in Table 3-4, then the solder **shall** be changed and the intervals between analyses **shall** be shortened. A sampling plan **shall** be developed, implemented, and documented, demonstrating solder contamination limit process control.

Table 3-4 Maximum Limits of Solder Bath Contaminant

Contaminant	Maximum Contaminant Weight Percentage Limit SnPb Alloys ^(1,2)	Maximum Contamination Weight Percentage Limit Pb-free Alloys ^(3, 4)
Copper	0.750	1.100
Gold	0.500	0.200
Cadmium	0.010	0.005
Zinc	0.008	0.005
Aluminum	0.008	0.006
Antimony	0.500	0.200
Iron	0.020	0.020
Arsenic	0.030	0.030
Bismuth	0.250	0.250
Silver	0.750	4.000
Nickel	0.025	0.050
Lead	N/A	0.100

Notes:

1. The tin content of the solder **shall** be maintained within $\pm 1.5\%$ of the nominal alloy being used. Tin content **shall** be tested at the same frequency as testing for copper/gold contamination. The balance of the bath **shall** be lead and/or the items listed above.
2. The silver contamination limit is not applicable for Sn62Pb36Ag2: limits to be 1.75% to 2.25%.
3. The tin content of the solder **shall** be maintained within $\pm 1\%$ of the nominal alloy being used. Tin content **shall** be tested at the same frequency as testing for copper/silver concentration. The balance of the bath **shall** be the items listed above.
4. Maximum contamination limits are applicable for Sn96.5Ag3.0Cu0.5 (SAC305) per J-STD-006. Other Pb-free solder alloy contamination limits may be used AABUS.

4 TEST PROCEDURES

4.1 Application of Flux Flux per 3.1.2 **shall** be used. Leads and terminations **shall** have flux applied uniformly and to cover the surfaces to be tested. The flux **shall** be at room temperature. This section (4.1) **shall** apply to all of the following tests: A, B, C, D, E, F, G, A1, B1, C1, E1, F1 and G1 but **shall not** apply to both tests S and S1, which require the use of solder paste and not a separate flux.

Axial, radial, and multiple leaded components intended for through-hole mounting **shall** have their leads immersed into the flux approximately perpendicular to the flux surface. Leaded or leadless components intended for surface mounting **shall** have their leads or terminations immersed at an angle between 20° and 45° to the flux surface. The surfaces to be tested **shall** be immersed in the flux for 5-10 seconds. Any droplets of flux that may form **shall** be removed by blotting, taking care not to remove the flux coating from the surfaces to be tested. For small passive surface mount devices, the flux droplets may be (but are not required to be) blotted from the surface. The specimens being tested **shall** be allowed to dry for 5-20 seconds before solder immersion, but **shall not** be allowed to dwell above solder-pot (no preheat) before actual dipping action.

4.2 Visual Acceptance Criteria Tests

4.2.1 Test A - SnPb Solder – Solder Bath/Dip and Look Test (Leads, Wires, etc.) This test is for solder bath/dip and look testing of leaded components, solid wires, and stranded wires greater than 0.254 mm [0.01 in] minimum.

4.2.1.1 Apparatus

4.2.1.1.1 Solder Pot/Bath A thermostatically controlled static solder vessel **shall** be used for all applicable tests. The solder vessel **shall** be of adequate dimensions to accommodate the specimens and contain sufficient solder to maintain the solder temperature during testing, and to prevent exceeding the contamination levels (see 3.4.1). A minimum of 750 grams of solder should be used.

4.2.1.1.2 Dipping Device A mechanical or electromechanical dipping device similar to the device shown in Figure 4-1 **shall** be used unless AABUS. The rate of immersion, dwell time, and rate of withdrawal **shall** be within the test limits defined in 4.2.1.3. Perpendicularity of through-hole component leads to solder surface **shall** be maintained. Leaded surface mount components **shall** be immersed at between 20° and 45° (or 90° or AABUS) to the solder surface (see Figure 4-2). This angle **shall** remain consistent for any given component type. Wobble, vibration, and other extraneous movements **shall** be minimized.

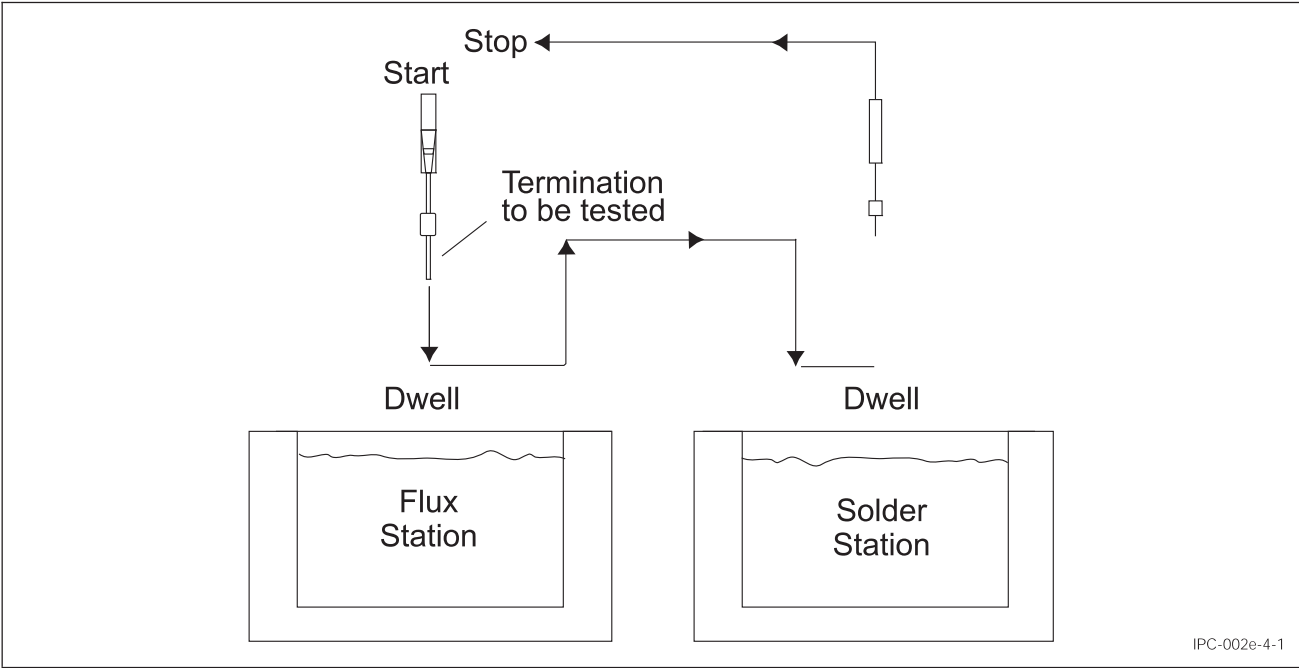


Figure 4-1 Dipping Schematic

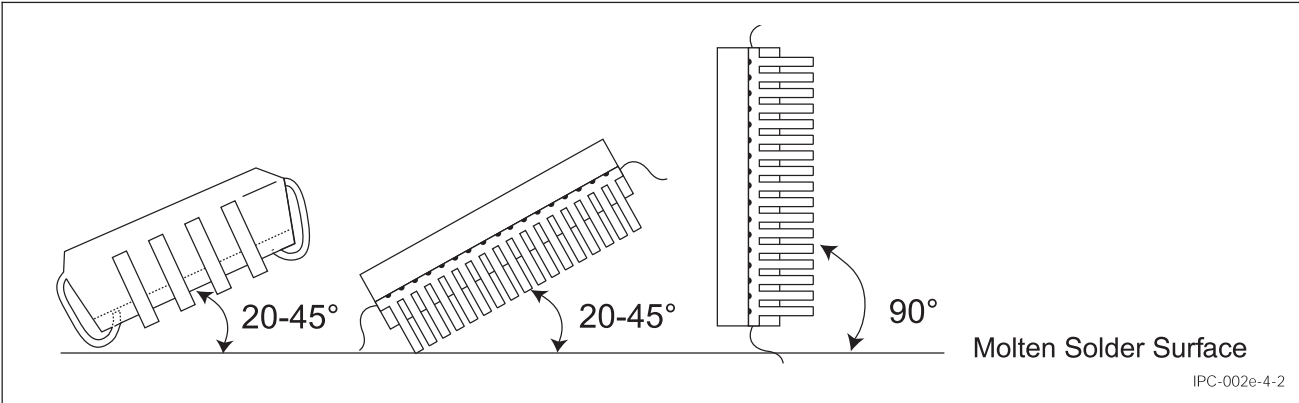


Figure 4-2 Solder Dipping Angle for Surface Mount Leaded Components

4.2.1.2 Preparation Specimen preparation and preconditioning for testing shall be in accordance with 3.3.

4.2.1.3 Test Parameters Test A solderability testing parameters are listed in Table 4-1.

Table 4-1 Test A Solderability Testing Parameters

Solder Process	Wave Soldering	Reflow Soldering	Pb-Free Soldering Backward Compatibility
Solder Type	SnPb per 3.1.1		
Flux Type	Standard Flux #1 per 3.1.2		
Flux Immersion Time	5 to 10 seconds		
Flux Immersion Angle	90° Nominal	20° - 45°	20° - 45°
Solder Temperature	245 ± 5 °C [473 ± 9 °F]	245 ± 5 °C [473 ± 9 °F]	215 ± 5 °C [419 ± 9 °F]
Solder Immersion Time	5 +0/-0.5 seconds	5 +0/-0.5 seconds	5 +0/-0.5 seconds
Solder Immersion / Emersion Rate	25 ± 6 mm/sec [0.984 ± 0.24 in/sec]		

4.2.1.4 Procedure

- Dross and burned flux **shall** be skimmed from the surface of the molten solder immediately before dipping.
- The fluxed specimen **shall** be immersed in the molten solder to within 1.27 mm [0.050 in] of the component body or to the seating plane (whichever is further from the component body) for through-hole leaded components (see Figure 4-3).
- Immerse and withdraw at 25 ± 6 mm [0.984 ± 0.24 in] per second and dwell for $5 +0/-0.5$ seconds (see 5.2).
- After withdrawal, the solder **shall** be allowed to solidify by air cooling while the specimen is maintained in the test attitude.
- Before examination, all leads **shall** have all visible flux residues removed. The cleaned surface **shall** exhibit no mechanical damage.

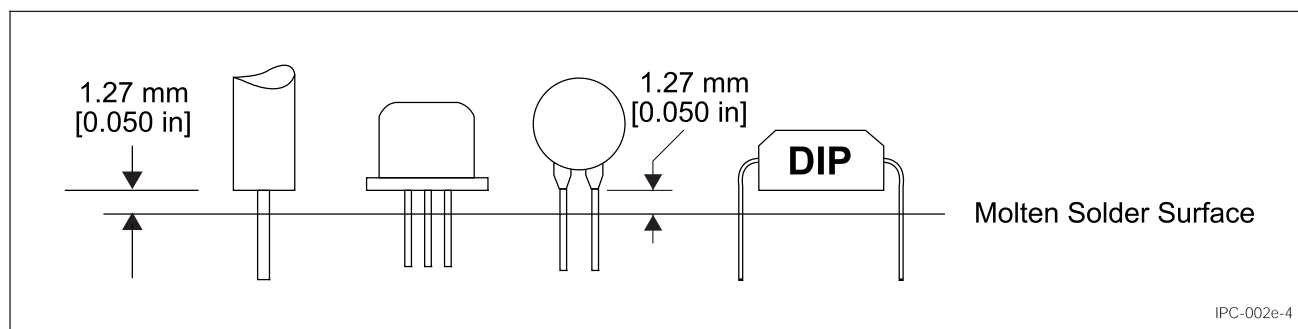


Figure 4-3 Solder Dipping Depth for Through-Hole Components

4.2.1.5 Evaluation

4.2.1.5.1 Magnification Parts **shall** be examined at 10X using the equipment specified in 3.2.3. For fine pitch leaded parts (0.5 mm [0.020 in] pitch or less) the inspection magnification **shall** be 30X.

4.2.1.5.2 Accept/Reject Criteria All leads **shall** exhibit a continuous solder coating free from defects for a minimum of 95% of the critical area of any individual lead. For exposed pad packages the exposed pad surfaces **shall** exhibit a continuous solder coating free from defects for a minimum of 80% of the critical area of those surfaces. Anomalies other than dewetting, nonwetting, and pin holes are not cause for rejection (see Appendices A and B). Exposed terminal metal is allowable on surface mount components at the toe end and on the vertical surfaces that are either unplated or sheared during component fabrication.

4.2.2 Test B - SnPb Solder – Solder Bath/Dip and Look Test (Leadless Components) This test is for solder bath/dip and look testing of leadless components.

4.2.2.1 Apparatus

4.2.2.1.1 Solder Pot/Bath A thermostatically controlled static solder vessel **shall** be used for all applicable tests. The solder vessel **shall** be of adequate dimensions to accommodate the specimens and contain sufficient solder to maintain the solder temperature during testing, and to prevent exceeding the contamination levels (see 3.4.1). A minimum of 750 grams of solder should be used.

4.2.2.1.2 Dipping Device A mechanical or electromechanical dipping device similar to the device shown in Figure 4-1 **shall** be used or AABUS. The rate of immersion, dwell time, and rate of withdrawal **shall** be within the test limits defined in 4.2.2.3. Surface mount leadless components **shall** be immersed at an angle to the solder surface of 20° - 45° and 90° for discrete chip components and exposed pad packages. Other immersion angles may be used AABUS.

4.2.2.2 Preparation Specimen preparation and conditioning for testing **shall** be in accordance with 3.3.

4.2.2.3 Test Parameters Test B solderability testing parameters are listed in Table 4-2.

Table 4-2 Test B Solderability Testing Parameters

Solder Process	Wave Soldering	Reflow Soldering	Pb-Free Soldering Backward Compatibility
Solder Type	SnPb per 3.1.1		
Flux Type	Standard Flux #1 per 3.1.2		
Flux Immersion Time	5 to 10 seconds		
Flux Immersion Angle	90° Nominal	20° - 45°	20° - 45°
Solder Temperature	245 ± 5 °C [473 ± 9 °F]	245 ± 5 °C [473 ± 9 °F]	215 ± 5 °C [419 ± 9 °F]
Solder Immersion Time	5 +0/-0.5 seconds	5 +0/-0.5 seconds	5 +0/-0.5 seconds
Solder Immersion / Emersion Rate	25 ± 6 mm/sec [0.984 ± 0.24 in/sec]		

4.2.2.4 Procedure

- Dross and burned flux **shall** be skimmed from the surface of the molten solder immediately before dipping.
- The fluxed specimen **shall** be immersed in the molten solder 0.10 mm [0.0039 in] minimum (see Figure 4-4). Immerse and withdraw at 25 ± 6 mm [0.984 ± 0.24 in] per second and dwell for 5 +0/-0.5 seconds. Massive components may require a longer molten solder dwell time (see 5.2).
- After withdrawal, the solder **shall** be allowed to solidify by air cooling while the specimen is maintained in the test attitude.
- Before examination, all terminations **shall** have all visible flux residues removed. The cleaned surface **shall** exhibit no mechanical damage.

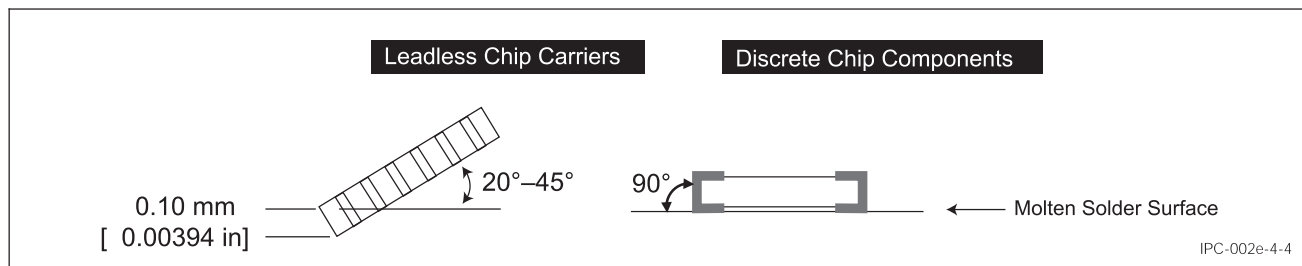


Figure 4-4 Leadless Component Immersion Depth

4.2.2.5 Evaluation

4.2.2.5.1 Magnification Parts **shall** be examined at 10X using the equipment specified in 3.2.3. For fine pitch termination parts (0.5 mm [0.020 in] pitch or less) the inspection magnification **shall** be 30X.

4.2.2.5.2 Accept/Reject Criteria All terminations **shall** exhibit a continuous solder coating free from defects for a minimum of 95% of the critical area of any individual termination. For exposed pad packages, the exposed pad surfaces **shall** exhibit a continuous solder coating free from defects for a minimum of 80% of the critical area of those surfaces. Anomalies other than dewetting, nonwetting, and pin holes are not cause for rejection (see Appendices A and B). Exposed terminal metal is allowable on surface mount components at the toe end and on the vertical surfaces that are either unplated or sheared during component fabrication.

4.2.3 Test C - SnPb Solder - Wrapped Wires Test (Lugs, Tabs, Terminals, Large Stranded Wires) This test is for wrapped wires testing of lugs, tabs, terminals, stranded wires greater than 1.016 mm [0.040 in] diameter, and solid wires greater than 1.143 mm [0.045 in] diameter.

4.2.3.1 Apparatus

4.2.3.1.1 Solder Pot/Bath A thermostatically controlled static solder vessel **shall** be used for all applicable tests. The solder vessel **shall** be of adequate dimensions to accommodate the specimens and contain sufficient solder to maintain the solder temperature during testing, and to prevent exceeding the contamination levels (see 3.4.1). A minimum of 750 grams of solder should be used.

4.2.3.1.2 Dipping Device A mechanical or electromechanical dipping device similar to the device shown in Figure 4-1 **shall** be used AABUS. The rate of immersion, dwell time, and rate of withdrawal **shall** be within the test limits defined in 4.2.3.3. Wobble, vibration, and other extraneous movements **shall** be minimized.

4.2.3.2 Preparation Specimen preparation **shall** be in accordance with 3.3.

- For application of standard solderable wires for lugs, tabs, terminals, stranded wires greater than 1.016 mm [0.040 in] diameter, and solid wires greater than 1.143 mm [0.045 in] diameter all specimens **shall** have a wrap of 1.5 turns of the standard wires around the portion of the specimen to be tested.
- The standard wrapping wires as described in 3.1.3 **shall** be wrapped in such a manner so that it will not move during the solder dip. Examples of this wrap are shown in Figures 4-5, 4-7 and 4-8.
- Special instructions concerning the portion of the specimens to be wrapped **shall** be specified in the individual specification, if necessary.
- For lugs and tabs designed to accept wires smaller than 0.6 mm [0.024 in] diameter, the standard copper wrapping wires specified in 3.1.3 **shall** be the same size for which the lugs and tabs are designed.

4.2.3.3 Test Parameters Test C solderability testing parameters are listed in Table 4-3.



Figure 4-5 Illustration of Acceptable Solderable Terminal



Figure 4-6 Illustration of Unsolderable Terminal



Figure 4-7 Illustration of Acceptable Solderable Stranded Wire

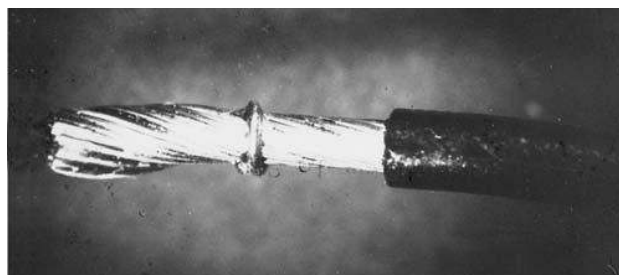


Figure 4-8 Illustration of Partially Solderable Stranded Wire Showing Incomplete Fillet

Table 4-3 Test C Solderability Testing Parameters

Solder Process	Wave/Manual Soldering
Solder Type	SnPb per 3.1.1
Flux Type	Standard Flux #1 per 3.1.2
Flux Immersion Time	5 to 10 seconds
Flux Immersion Angle	90° Nominal
Solder Temperature	245 ± 5 °C [473 ± 9 °F]
Solder Immersion Time	7 +0/-0.5 seconds
Solder Immersion / Emersion Rate	25 ± 6 mm/sec [0.984 ± 0.24 in/sec]