

ENGINEERING PRACTICE STUDY

PROJECT NUMBER: 5961-2018-051

TITLE:

MIL-STD-750-2, TEST METHOD 2026

PROPOSAL TO REVISE THE
SOLDERABILITY REQUIREMENTS FOR 5961 PRODUCT

31 OCTOBER 2018

FINAL REPORT

STUDY CONDUCTED BY

DLA LAND AND MARITIME
DOCUMENT STANDARDIZATION DIVISION (VA)
ACTIVE DEVICE BRANCH (VAC)

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I. OBJECTIVES: The objective of this Engineering Practice (EP) study was to obtain comments or concurrence from the military services, device manufacturers, laboratories, OEMs, and the user community concerning a proposed revision to test method 2026 of MIL-STD-750-2 (see attachments 1 and 2).

II. BACKGROUND: At a past JEDEC 13.1 committee meetings, DLA VAC was tasked with investigating if test method 2026 could be revised to be more aligned with the recently updated test method 2003 of MIL-STD-883. The proposed test method 2026.13 is a combination of test method 2003 of MIL-STD-883 and test method 2026. The details used from test method 2026 were the acceptability requirements for FSC 5961 packages and solder terminal/hand soldering details not covered by test method 2003. After performing a review of the content of test method 2003.13 and the legacy test method 2026.10 of MIL-STD-750D, additional consistency, editorial, and organization issues were noted, corrected and have been incorporated in the proposed test method 2026.13.

The initial draft of this EPS with the draft of test method 2026.13 was coordinated to the FSC 5961 community and DLA Land and Maritime had requested that those activities that have an interest in test method 2026 to review the proposed revision.

III. RESULTS: Only a few suggested and editorial comments were received regarding the content of the proposed revision. Those comments were easily incorporated into the final report draft.

IV. CONCLUSIONS: The format and technical changes as proposed for test method 2026.13, as documented in attachment 1, should be proposed for incorporation into the next standardization document change action to MIL-STD-750-2. Attachment 2 is the record of changes made to both the initial draft and the final draft.

V. RECOMMENDATIONS: Prepare an initial draft of MIL-STD-750-2 with the results of this study used for the draft of test method 2026.13.

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METHOD 2026.13

SOLDERABILITY

1. Purpose. The purpose of this test method is to provide a referee condition^s for the evaluation of the solderability of leads, pads, pins and solder terminals (hereafter referred to as 'terminals') of semiconductor devices that will be assembled using tin-lead eutectic solder (hereafter referred to as 'solder'). This evaluation is made on the basis of the ability of these terminals to be wetted by solder.

2. Overview. This test method describes three solderability test conditions by which terminals may be evaluated for solderability. These test conditions can be used to determine whether the materials and processes used during the manufacturing operations produce a device that can be successfully soldered to the next level of assembly. Two different terminal finish preconditioning procedures are included in this test method. The purpose of these preconditioning procedures are to degrade the terminal finish to provide a guard band against marginal terminal finishes.

2.1 Test conditions.

2.1.1 Covered herein. The three solderability test conditions detailed in this test method are as follows:

- a. Test condition D is a dip soldering procedure. The procedure of this test condition can be used on leaded and leadless devices.
- b. Test condition H is a hand soldering procedure. The procedure of this test condition assembles standard wrapped wire onto devices with solder terminals.
- c. Test condition S is a reflow soldering surface mount simulation procedure. The procedure of this optional test condition simulates the assembly of the surface mount device (SMD) to a non-wetting substrate.

2.1.2 Covered by other documents. The test conditions covered by non-Government standard test methods are addressed by MIL-STD-202-208 as follows:

- a. Test A. For through hole mount and surface mount leaded components with terminals less than .045 inch (1.14 mm) in diameter.
- b. Test B. For surface mount leadless components.
- c. Test C. For solder terminals and terminal greater than .045 inch (1.14 mm) diameter.

2.2 Terminal finish preconditioning categories. The terminal finish preconditioning categories are as follows:

- a. Category A: This category is intended to be used on all device terminal finishes which have no Gold or Tin content specified (steam for 1 hour ±5 minutes).
- b. Category C: This category is intended for all other device terminal finishes, including those containing Gold and Tin (steam for 8 hours ± 15 minutes).
- c. Category E: This category is intended to be used on all device terminal finishes, including those containing Gold and Tin (dry-bake for 4 hours ± 15 minutes).

2.3 Test classification. Solderability testing of devices is classified as a destructive test.

3. Definitions.

3.1 Terms used in this test method. The definitions of terms used in this test method are specified in MIL-PRF-19500 and herein.

3.1.1 Foreign material. Particles of material located on, but different from, the terminal material or terminal finish.

3.1.2 Pinholes (see figure 2026-1). An imperfection in the form of a small hole that penetrates through a layer of material.

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

3.1.4 Terminal. A metallic device that is used for making electrical connections. Terminals includes component leads, pads, pins and solder terminals up to .125 inch (3.18 mm) in diameter.

3.1.4.1 Leded through hole mount. The electrical connection of components to a conductive pattern by the use of component holes. Examples of leded through hole mount packages used on MIL-PRF-19500 specification sheets includes axial, DIPs, certain DO and TO cans.

3.1.4.2 Leded surface mount. A surface-mount component for which external connections consist of terminals that are around and down the side of the package. Examples of leded surface mount devices used on MIL-PRF-19500 specification sheets include Button-Tab, SOT-23, ThinKey, and U2L.

3.1.4.3 Leadless surface mount. A surface-mount component whose external connections consist of metallized terminals that are an integral part of the component body. Examples of leadless surface mount devices used on MIL-PRF-19500 specification sheets include LCC, U, UA, and U5.

3.1.4.4 Radial leded. A component where the terminals are located on the bottom, radially and parallel to the central axis. Examples of radial leded packages used on MIL-PRF-19500 specification sheets include TO-3, TO-39, and TO-205AA.

3.1.4.5 Solder terminal. An electrical-mechanical connection surface that is used to terminate a discrete wire or wires by soldering. Types included are bifurcated, cup, hook, perforated and turret style solder terminals. Examples of solder terminal packages used on MIL-PRF-19500 specifications sheets include DO-4, TO-61 and TO-63.

3.1.5 Wetting. The formation of a relatively uniform, smooth, unbroken and adherent film of solder to the surface of a base metal.

3.1.5.1 Dewetting (see figure 2026-2). A condition that results when molten solder has coated a surface and then receded leaving irregularly shaped mounds of solder separated by areas covered with a thin film of solder and with the base metal not exposed.

3.1.5.2 Nonwetting (see figure 2026-3). A condition whereby a surface has contacted molten solder, but the solder has not adhered to all of the surface, leaving the surface base metal partially or totally exposed.

3.1.6 Critical area. The critical areas of a terminal are those areas identified that shall be covered with solder and complies with the minimum acceptance limits after solderability testing.

3.2 Acronyms used in this test method. The acronyms used in this test method are as follows.

3.2.1 DIP. Dual In-line Package.

3.2.2 DO. Diode-Outline.

3.2.3 TQ. Transistor-Outline.

3.2.4 LCC. Leadless Chip Carrier.

3.2.5 MELF. Metal Electrode Leadless Face.

3.2.6 QFN. Quad Flat No-leads.

3.2.7 SMD. Surface mount device.

3.2.8 UR. Unleaded Round.

3.2.9 URS. Unleaded Round Square.

3.2.10 DUT. Device under test.

3.2.11 IR. Infra-red.

4. General requirements.

4.1 Apparatus. Not all equipment listed below is applicable or required for each test condition.

4.1.1 Apparatus for test condition D (dip soldering procedure).

4.1.1.1 Dipping mechanism. The dipping mechanism shall be capable of controlling the rates of immersion and emersion of the terminals and provide a dwell time (total time at the required depth) in the solder bath as specified in 5.5.1. The dipping mechanism shall be also capable of orienting and dipping the terminals of the device to meet the dipping immersion angle requirements specified in 5.5.1. The device holder of the dipping mechanisms shall be designed to minimize the trapping of flux.

4.1.1.2 Solder bath. The solder bath shall be a thermostatically controlled vessel of sufficient size to contain at least two pounds (0.9 Kg) of solder. The molten solder shall be static during the dipping procedure. The solder bath shall be capable of maintaining the solder at the temperature specified in 4.3.1.

4.1.2 Apparatus for test condition H (hand soldering procedure).

4.1.2.1 Soldering iron. The soldering iron shall be a conduction temperature controlled apparatus capable of appropriate thermal capacity adequate to allow the solder connection to be made solidly and maintain proper soldering temperature throughout the soldering operation.

4.1.2.2 Fixture. Fixtures, when required, shall be made of a non-solderable material designed so that they will make minimum contact (i.e., minimum heat sink) with the DUT or DUT assembly.

4.1.3 Apparatus for test condition S (reflow soldering surface mount simulation procedure). Alternative automated solder paste dispensing systems (e.g., jet printing) may be used that do not require the use of a stencil, base fixture or squeegee.

4.1.3.1 Stencil. The stencil used to screen print solder paste shall be metal or other acceptable material (such as plastic) with pad geometry openings appropriate for the device being tested. Unless otherwise specified, the nominal stencil thickness shall be as follow:

- a. For devices with a lead pitch < .020 inch (0.51 mm): .004 inch (0.10 mm).
- b. For devices with a lead pitch ≥ .020 inch (0.51 mm) and up to .025 inch (0.635 mm): .006 inch (0.15 mm).
- c. For devices with a lead pitch > .025 inch (0.635 mm): .008 inch (0.20 mm).

4.1.3.2 Squeegee. The squeegee shall be a rubber, plastic, or metal tool used to print the solder paste.

4.1.3.3 Base fixture. The base fixture shall be designed to hold the substrate and aid in the alignment of the stencil.

4.1.3.4 Reflow soldering equipment. The equipment used for reflow soldering shall be a system capable of achieving the specified (see 5.5.3) or recommended (see 6.a.3) reflow soldering profile.

4.1.4 Apparatus for device terminal preconditioning.

4.1.4.1 Steam preconditioning equipment. The steam preconditioning equipment shall consist of a chamber, accessories and fixtures needed for holding the devices undergoing steam preconditioning. The steam preconditioning equipment shall be constructed of a corrosion resistant and non-contaminating material. The steam preconditioning equipment shall be capable of continuously maintaining the devices undergoing preconditioning at the parameters specified in 5.4. The equipment shall be capable of having the specified temperature verified.

4.1.4.2 Dry bake preconditioning equipment. The dry bake preconditioning equipment shall consist of an oven, accessories and fixtures needed for holding the devices undergoing dry bake preconditioning. The oven shall be of sufficient size and capable of continuously maintaining the devices undergoing preconditioning at 150°C ±5°C. Temperature control shall be used. The equipment shall be capable of having the specified temperature verified.

4.1.4.3 Drying oven. The oven used for baking moisture out of the devices shall be capable of maintaining a set temperature within the range of 85°C to 115°C.

4.1.5 Lighting equipment. The lighting equipment to be used for visual inspection shall be a system that will provide a uniform, non-glare, non-directional illumination of the device.

4.1.6 Optical equipment. The optical equipment to be used for visual inspection shall be a stereo optical system capable of providing a minimum magnification of that required for post-test terminal inspection (see 5.7). The optical system shall be equipped with reticles, or equivalent, for taking measurements.

4.1.7 Storage chamber. The chamber used for storing devices between their preparation and testing shall be a desiccant jar, dry nitrogen cabinet, or other suitable chamber.

4.1.8 Temperature measurement apparatus. The temperature measurement apparatus shall be a thermocouple indicator or other suitable devices that can be used to measure the oven, solder, or vapor temperature.

4.1.9 Timing apparatus. When applicable, timing equipment which can indicate time in seconds shall be used to determine the time in which the DUT is exposed to molten solder or temperatures of the reflow soldering chambers. Timing equipment shall be automated and accurate to the limits of the test condition or procedure used.

4.2 Materials. Unless otherwise specified, all chemicals shall be of commercial grade or better.

WARNING: These materials may involve substances that are flammable, toxic to eyes, skin, or respiratory tract, or present a serious burn potential. Eye and skin protection should be used.

4.2.1 Cleaning solution. The cleaning solutions (e.g. isopropyl alcohol) used for flux residue removal after the solderability test shall be compatible with the device. Fresh cleaning solutions should be used as often as is necessary to preclude contamination.

4.2.2 Flux.

4.2.2.1 Standard testing flux. The standard testing flux shall be an activated rosin flux having a composition of 25 $\pm$ 0.5 percent by weight of Colophony (rosin) and 0.15 $\pm$ 0.01 percent by weight Diethylamine Hydrochloride (CAS 660-68-4), in 74.85 $\pm$ 0.05 percent by weight of Isopropyl Alcohol.

4.2.2.2 Alternate testing flux. When specified, low activity fluxes conforming to ROL0 or ROL1 may be substituted for the standard testing flux.

4.2.2.3 Maintenance. The flux shall be kept at ambient room temperature when in use and shall be covered when not in use. Once put into use, the flux shall be discarded after eight hours. Alternatively, if the standard testing flux can be maintained to a specific gravity of 0.843 $\pm$ 0.005 at 25 $\pm$ 2°C, it can be used for a maximum of 7 days before being discarded.

4.2.3 Solders.

4.2.3.1 Solder. The solder shall be alloy composition Sn63Pb37, Sn60Pb40, or equivalent. The tin content of the solder shall be maintained within $\pm$ 1 percent of the nominal alloy being used.

4.2.3.2 Solder paste. The solder paste shall be alloy composition Sn60Pb40, Sn63Pb37, or equivalent, flux type ROL1. The solder paste shelf life and storage conditions shall be in accordance with the solder paste manufacturer's requirements.

4.2.3.3 Solder ribbon or wire (test condition H only). When applicable, the solder ribbon or wire alloy shall be in accordance with 4.2.3.1. If applicable, the flux of fluxed-core solder ribbon or wire shall be in accordance with 4.2.2.

4.2.4 Standard wrapping wire (test condition H only). The standard wrapping wire shall be fabricated from type H, class S, annealed, uncoated in accordance with A-A-59551, Wire, Electrical, Copper (Uninsulated). The diameter of the standard wrapping wire shall be .025 $\pm$ 0.005 inch (0.635 mm $\pm$ 0.13 mm).

4.2.5 Substrate (test condition S only). Unless otherwise specified, the non-wetting substrate used for the reflow soldering surface mount simulation procedure shall be ceramic. The typical thickness of the substrate should be from .025 to .035 inch (0.635 mm to 0.889 mm). Substrates constructed of other non-wettable materials may be used when specified (see 6.a.3).

4.2.6 Water. The water used for steam preconditioning purposes shall be either distilled or deionized.

4.3 Soldering temperatures and solder composition maintenance.

4.3.1 Soldering temperatures.

4.3.1.1 Reflow soldering chambers. The reflow soldering chamber shall be capable of generating the environments (heating rates, temperatures, etc.) in accordance with [table 2026-I](#) or as specified (see [6.a.3](#)). The reflow soldering equipment shall be capable of maintaining an accuracy of $\pm 1^{\circ}\text{C}$ at the temperature range of interest.

4.3.1.2 Solder bath. The solder bath shall be capable of maintaining the solder at a uniform temperature of 245°C ($473^{\circ}\text{F} \pm 9^{\circ}\text{F}$).

TABLE 2026-I. Reflow soldering parameter requirements.

Method	Peak temperature ($^{\circ}\text{C}$)	Time (above 183°C)
Vapor phase reflow	215 – 219	30 – 90 seconds dwell at reflow
IR reflow or forced-air convection reflow	150 – 170 preheat	50 – 70 seconds
	200 – 230 reflow	50 – 70 seconds
Storage oven reflow	215 – 230	2 – 5 minutes (until reflow is assured)

NOTE: Table 2026-I reflow parameter values are for solderability testing purposes only and are not related to moisture sensitivity level reflow test parameters. These reflow soldering parameters refer to measurements taken on the device body.

4.3.1.3 Soldering iron.

4.3.2 Temperature measurements.

4.3.2.1 Reflow soldering chamber. Low mass thermocouples that do not affect the heating rate of the DUT shall be used. A temperature recording device is recommended.

4.3.2.2 Solder bath. A thermocouple or other suitable devices shall be used to measure the solder temperature. The solder bath temperature shall be measured in the center of the bath at a depth of at least .750 inch (20 mm), but no deeper than 1 inch (25 mm) below the surface of the solder.

4.3.3 Solder bath maintenance.

4.3.3.1 Solder composition and contaminants. The composition of the solder, including level of contaminants, shall be monitored and maintained. The solder bath shall be analyzed (either chemically or spectrographically) or replaced after 30 operating days as a minimum. An operating day consists of any eight-hour period, or any portion thereof, during which the solder is liquefied. A procedure shall be developed, documented, and implemented demonstrating that the solder composition and levels of solder contamination remains in control.

4.3.3.2 Control of solder contamination. The levels of solder contamination shall be within those shown in [table 2026-II](#). If contamination of the solder bath exceeds the limits specified in [table 2026-II](#), then the solder shall be changed and the intervals between analysis shall be shortened. The intervals between analysis may be lengthened if the analysis results indicate that the levels of contamination limits are not being approached.

TABLE 2026-II. Solder bath contaminant limits.

Contaminant	Maximum contaminant weight percentage limit	Contaminant	Maximum contaminant weight percentage limit
Aluminum (Al)	0.006 1/	Gold (Au)	0.200 1/
Antimony (Sb)	0.500	Iron (Fe)	0.020
Arsenic (As)	0.030	Nickel (Ni)	0.010
Bismuth (Bi)	0.250	Silver (Ag)	0.100
Cadmium (Cd)	0.005 1/	Zinc (Zn)	0.005 1/
Copper (Cu)	0.300 1/		

1/ The total of Aluminum, Cadmium, Copper, Gold, and Zinc contaminants shall not exceed 0.4 percent.

4.3.3.3 **Tin content.** The Tin (Sn) content of the solder bath shall be maintained within ± 1.0 percent of the nominal solder alloy being used. The Tin content shall be tested at the same frequency as testing for Copper (Cu) and Gold (Au) contamination. The balance of the solder bath shall be Lead (Pb) and the other elements listed in table 2026-II.

4.4 **Procedures of test conditions covered by external test methods.** When specified, the procedures for solderability test conditions covered by external test methods shall be performed in accordance with the current revision of MIL-STD-202-208.

5. Detailed requirements.

WARNING: Heat resistant gloves should be used when handling hot objects.

5.1 **Test procedure operations.** The entire procedure for each solderability test condition shall consist of the following operations:

- Selection of samples to be tested (see 5.2).
- Proper preparation of the terminals (see 5.3), if applicable.
- Preconditioning of all terminals (see 5.4).
- Solderability test procedure (see 5.5).
- Post-test removal of residual flux from terminals (see 5.6).
- Examination and evaluation of the tested portions of the terminals (see 5.7).

5.2 **Sampling.** The test procedure shall be performed on the number of terminals specified in the performance specification or acquisition document. If no sample size is specified, then the sample size shall be 22 terminals with no failures. The terminals to be tested shall be selected at random from at least 3 different devices. The solderability test procedure may be performed just prior to packaging for storage or shipment, immediately upon removal from the manufacturer's protective packaging, or as a qualification or conformance inspection.

5.3 Preparation of terminals and standard wrapping wire.

5.3.1 Preparation of terminals. The devices shall be handled in such a manner as to prevent the terminals to be tested from being contaminated by abnormal atmospheres, grease, or perspiration. The terminals to be tested shall not be abraded, cleaned, scraped, or wiped prior to testing.

5.3.2 Preparation of standard wrapping wire (test condition H only). The preparation of the standard wrapping wire shall be as follow:

- Straighten and cut wire into convenient lengths. A minimum length of 2 inches (50.80 mm) is recommended.
- Clean or degrease as necessary to ensure the wire surface is free of contaminants.
- Immerse wire in flux.
- Dip wire in molten solder for 5 seconds.
- Rinse or wash wire in cleaning solution to remove or dissolve the residual flux.

Standard wrapping wire shall 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 solder coating.

5.3.3 Special preparation of terminals. Any special preparation of the terminals, such as bending or reorientation prior to the solderability test, shall be as specified in the performance specification or acquisition document (see 6.e).

5.4 Terminal finish preconditioning. The terminal finish preconditioning categories shall be as specified in table 2026-III.

TABLE 2026-III. Terminal finish preconditioning parameters.

Category	Precondition	Exposure time	Applicability by finish	Use
A	Steam	1 hour ±5 minutes	For non-Gold and non-Tin alloy finishes.	When specified
C	Steam	8 hours ±15 minutes	All terminal finishes	When specified
E	Dry bake	4 hours ±15 minutes	All terminal finishes	Default

5.4.1 Steam preconditioning (categories A and C).

5.4.1.1 General. Prior to the application of the flux and subsequent solderability testing, devices to be tested designated as precondition category A or C shall be subjected to steam preconditioning for the exposure time applicable for the category.

5.4.1.2 Procedure. When devices are being exposed to steam in the steam preconditioning chamber, the following details shall apply:

- a. The steam temperature at the terminal level shall be in accordance with table 2026-IV.
- b. The steam preconditioning may be interrupted once for 10 minutes maximum.
- c. The devices shall be suspended so that no portion of the device is less than 1.5 inches (38 mm) above the boiling water.
- d. The devices shall be placed so that no device has its terminals touching any other device or the steam preconditioning chamber.
- e. The devices shall be arranged in such a manner as to avoid condensate dripping on the devices undergoing preconditioning.
- f. When possible, the devices shall be placed with their terminals facing up ("dead-bug" orientation).

The devices shall be removed from the steam preconditioning chamber upon completion of the exposure time specified in table 2026-III.

TABLE 2026-IV. Altitude versus steam temperature.

Altitude (feet)	Average boiling point (°C)	Steam temperature (+/-3°C)
0 - 1,000	100	93
1,001 - 2,000	99	92
2,001 - 3,000	98	91
3,001 - 4,000	97	90
4,001 - 5,000	96	89
5,001 - 6,000	95	88
Greater than 6,000	95	87

5.4.1.3 Post steam preconditioning drying procedures. Upon removal of devices from the steam preconditioning chamber, the devices shall be dried (if applicable) using one of following procedures:

- a. Air dry at ambient temperature for a minimum of 15 minutes.
- b. Bake at 100°C maximum for no more than 1 hour in a dry atmosphere. A dry nitrogen atmosphere is recommended.

5.4.1.4 Cleaning of the system. The steam preconditioning chamber shall be drained and cleaned at least once each month or prior to use. A more frequent cleaning cycle may be necessary as indicated by resistivity, visual, or general cleanliness of the water. No contaminating solvents shall be used to clean the chamber, accessories and fixtures.

5.4.2 Dry bake preconditioning (category E).

5.4.2.1 General. Prior to the application of the flux and subsequent solderability testing, devices designated as precondition category E shall be subjected to dry-bake preconditioning.

5.4.2.2 Procedure. The devices to be tested shall be placed in the chamber and subjected to dry-bake preconditioning. Dry-bake preconditioning may be interrupted once for 10 minutes maximum. The devices shall be removed from the dry-bake preconditioning chamber upon completion of the time period specified in table 2026-III.

5.4.3 Post preconditioning storage requirements. If solderability testing cannot be performed within 2 hours after preconditioning, then the devices shall be stored in a low humidity environment (desiccant jar or dry nitrogen cabinet).

5.4.4 Post preconditioning dwell time. If solderability testing cannot be performed on the devices within 72 hours after removal from the preconditioning equipment, either a new sample of devices shall be preconditioned or the existing sampled devices shall be re-submitted to preconditioning.

5.5 Solderability test conditions.

5.5.1 Test condition D (dip soldering procedure). The dip soldering procedure can be used to test the following packages:

- a. Leaded through hole mount.
- b. Leaded surface mount.
- c. Leadless surface mount.

5.5.1.1 Application of flux. The critical area of the terminal (see figures 2026-4 through 2026-12) to be tested shall be immersed in the flux for 5 to 10 seconds and shall be drained for 5 to 20 seconds prior to dipping in the solder bath. Any obvious droplets of flux clinging to the terminals may be removed by blotting.

5.5.1.2 Preparation of solder bath before testing. The dross and burned flux shall be skimmed from the surface of the molten solder prior to testing. A wave soldering apparatus may be used for this purpose, but the solder shall be static during the dipping procedure (skimming may not be required in wave or flow pots).

5.5.1.3 Solder dipping. The device shall be attached to the dipping mechanism (see 4.1.1.1) and the flux covered terminals immersed in the molten solder at the dipping rate, dwell time, immersion angle, depth, and for the number of cycles specified. The following details apply:

- a. **Axial and SMDs (leaded and leadless) packages.** Perform the dip soldering test on the terminals on one side of the device at a time. The fluxing and solder dipping operations shall be performed sequentially on the terminals of the side under test.
- b. **Bottom pad SMD, radial, and solder terminal packages.** The fluxing then dip soldering operations shall be performed sequentially on all terminals undergoing testing.

5.5.1.3.1 Dipping (immersion and emersion) rate. The immersion and emersion rates shall be 1.0 inch $\pm$.250 inch (25.4 mm $\pm$ 6.35 mm) per second.

5.5.1.3.2 Dwell time. The device shall not be suspended above the molten solder for longer than 7 seconds. The dwell time in the solder shall be as follows:

- a. **For terminals less than .040 inch (1.02 mm) in diameter:** 5 seconds $\pm$ 0.5 second.
- b. **For terminals greater than or equal to .040 inch (1.02 mm) in diameter:** 7 seconds $\pm$ 0.5 second.

After the solder dipping process, the device shall be allowed to cool in air.

5.5.1.3.3 Immersion angle (see figure 2026-13). Unless otherwise specified, the angle at which terminals are immersed into the solder shall be as follows:

- a. Leaded through hole mount: 90°
- b. Leaded and leadless surface mount with 3 or less terminals: 90°
- c. Leadless and leadless surface mount with 4 or more terminals: 20° to 45°

5.5.1.3.4 Immersion depth (see figures 2026-13 and 2026-14). Unless otherwise specified, the depth to which terminals are immersed into the solder shall be as follows:

- a. SMDs (leaded and leadless). The device shall be immersed in the solder to the minimum depth of .004 inch (0.1 mm). The device shall be immersed in the solder to the minimum depth necessary to cover the critical area of the terminals being tested.
- b. All other devices except those with solder terminals. The terminals shall be immersed in the solder to the seating plane or to within .05 inch (1.27 mm) of the package body of the DUT.
- c. Devices with solder terminals. When using the dip soldering procedure on devices with solder terminals, the terminal with wrapping wire shall be immersed in the solder to a minimum depth of .05 inch (1.27 mm) past the wrapping area.

5.5.1.3.5 Number of dipping cycles.

5.5.1.3.5.1 Terminals with non-Gold finishes. Devices with non-Gold finish terminals shall be cycled once in flux and solder, except for the possible duplicate immersion of corner terminals on leadless surface mount devices.

5.5.1.3.5.2 Terminals with Gold finish. Devices with Gold plated terminals shall be cycled twice in flux and solder using either one or two solder baths. The first dip is to scavenge the Gold on the terminals. The second dip is the solderability test. If two solder baths are used, only the second solder bath is required to be monitored for contaminants in accordance with 4.3.3.

NOTE: It is recommended that a separate solder bath be used for the first dip of Gold plated terminals. In any case, the user of this test condition should use either two separate solder baths, a sufficiently large solder bath, or monitor closely the contamination level of a single small solder bath to assure that the solder complies with requirements of 4.3.3.

5.5.2 Test condition H (hand soldering procedure). The hand soldering procedure can be used on terminals not designed for wave or reflow soldering assembly. These terminals are typically hooks, lugs, posts, turrets and other terminal configurations generally having specific wire attachment areas such as hole, notch, or slot. When the device has more than one solder terminal, all solder terminals on the device shall be tested.

5.5.2.1 Application of standard wrapping wire. Prior to application of flux and subsequent soldering, the wire attach area of the terminal shall be wrapped 1 to 1.5 turns using the standard wrapping wire (see 4.2.4). The standard wrapping wire shall be wrapped such that it will not move during soldering.

5.5.2.2 Application of flux. Flux shall be applied to both the standard wrapping wire and the attach area of the terminal using any suitable method (e.g. brushing or dipping). Excess flux may be blotted or drained from the terminal prior to soldering.

5.5.2.3 Hand soldering. The terminal and standard wrapping wire shall be soldered using the solder specified (see 4.2.4 and 6.h) and the soldering iron specified in 4.1.2. Heat shall be applied to the connection until the solder has been molten for 5 seconds minimum to 10 seconds maximum. After soldering, the assembly shall be allowed to air cool.

5.5.2.4 Alternative to hand soldering. As an alternative to hand soldering, the solder terminal with standard wrapping wire may utilize the dip soldering procedure of 5.5.1 to form the assembly of the standard wrapping wire to the solder terminal.

5.5.3 Test condition S (reflow soldering surface mount simulation). The reflow soldering surface mount simulation procedure simulates surface mount device assembly process and can be performed on SMD packages. The reflow soldering surface mount simulation procedure shall be used only when specified (see 6.a).

5.5.3.1 Preparation of substrate. The printing of solder paste onto the substrate can use either a manual or automated procedure as follows:

- a. **Manual printing.** Place the substrate onto the base fixture. Place the screen print stencil on the substrate. Apply the solder paste uniformly across the stencil to fill the pattern using the squeegee. Slowly remove the stencil off the substrate to avoid smearing the solder paste print.
- b. **Automated printing.** If automated printing equipment is used, follow the equipment manufacturer's recommended procedure for printing the solder paste to the substrate.

After the solder paste has been printed onto the substrate, verify that the printed pattern is equivalent in geometry to the terminal pattern of the device to be tested. Lastly, gently press the device down to allow the device terminals to make contact with the solder paste.

5.5.3.2 Procedure. Place the substrate with device in the applicable reflow soldering apparatus. The reflow soldering profiles shall be in accordance with 4.3.1.1 based on the reflow soldering method used. After reflow soldering has completed, remove the assembly from the soldering apparatus and allow it to cool to room temperature before handling. After the cool down, slowly remove the device from the substrate. The terminals may adhere slightly to the substrate due to flux residue.

5.6 Terminal cleaning.

5.6.1 Post solder exposure flux removal. All residual flux is to be removed prior to visual inspection of the terminal surface(s). Residual flux can be removed from the terminals by dipping the device terminals in a suitable cleaning solution. If necessary, a clean soft cloth, cotton swab, or equivalent, moistened with cleaning solution, may be used to aid in the removal of flux.

5.6.2 Optional pre-solderability testing terminal cleaning. When specified, the customer/device manufacturer has the option of cleaning devices to remove carbonate/sulfate deposits caused by exposure of the devices to the steam preconditioning. The customer/device manufacturer shall assure that the cleaning process does not adversely affect the physical, mechanical, electrical, or reliability performance of the devices. This pre-solderability testing cleaning process shall be documented.

5.7 Examination of terminals.

5.7.1 Inspection conditions. For devices that were subjected to test condition S, the terminals shall be examined as specified. For devices that were subjected to test conditions D or H, the solder covered portion of the terminals shall be examined at the following magnification:

- a. For devices with terminal pitch $> .020$ inch (0.5 mm): 10 - 15x.
- b. For devices with terminal pitch ≤ 0.020 inch (0.5 mm): 30x.
- c. Verification of failures may be accomplished with higher magnifications up to 60x.

5.7.2 Critical area for terminals detailed herein. Examples of critical areas for some device packages shall be as detailed below.

- a. Bottom pad ceramic packages. The bottom and side of the terminal, excluding the top side of the package. See figure 2026-4.
- b. Dual-in-line. For packages where the terminals enter from the side of the device, from the terminal tip to .020 inch (0.51 mm) above the seating plane. For packages where the terminals exit from the bottom of the device, from the terminal tip to the seating plane. See figure 2026-5.
- c. Gull wing. All surfaces of the terminal at or below the top of the foot, excluding the top of the foot. See figure 2026-6.
- d. J-lead. The narrow portion of the terminal below the transition from the terminal shoulder. Only the three visible surfaces are to be included. The terminal tip is excluded. See figure 2026-7.
- e. Leadless chip carrier. The bottom of the terminal and $\frac{2}{3}$ of the height of the connecting metallized surface. See figure 2026-8.
- f. MELFs (UR, US and URS). The entire end cap surface excluding the inner rim. See figure 2026-9.
- g. QFN. The bottom of the terminal and exposed pad. See figure 2026-10.
- h. Round terminals or pins. The area above the seating plane that is within .050 inch (1.27 mm) of the bottom of the package body or .030 inch (0.76 mm) above seating plane, whichever is the lesser distance. See figure 2026-11.
- i. Solder terminals. The identified surfaces of the terminal where the wire is intended to be wrapped. See figure 2026-12.

5.7.3 Critical area for terminals not illustrated. For terminals on packages not illustrated herein, the following details shall apply:

- a. If the seating plane is not defined, the critical area shall extend from the terminal tip to within .040 inch (1.02 mm) of the terminal/device interface.
- b. For top brazed and bottom brazed flat pack devices, the critical area shall extend from the terminal tip to within .070 inch (1.78 mm) of the terminal-package body interface.

5.7.4 Areas to be excluded. For leaded devices only, the cut or trimmed portions of the terminal which expose the unplated areas or ends shall not be used for examination and evaluation of the solder coverage of the terminal.

5.7.5 Customer or device manufacturer defined criteria. The customer/device manufacturer may establish a critical zone within the solder coated portion of the terminal. The customer/device manufacturer has the option to accept solderability defects outside their established critical zone.

5.8 Criteria for acceptance.

5.8.1 Evaluation of all devices, except those with solder terminals. The criteria for acceptable solderability shall be as follows:

- a. The dipped portion of the terminals is at least 95 percent covered by a continuous new solder coating.
- b. Pinholes, nonwetting, or dewetting do not exceed 5 percent of the total solder coated area.
- c. For leadless terminals, there shall be no solder bridging between any terminal area and any other metallization not connected to it by design. In the event that the dip soldering causes bridging, the test shall not be considered a failure provided that a local application of heat (e.g., gas, soldering iron, or re-dipping) results in solder pullback and no wetting of the dielectric area as indicated by microscopic examination.
- d. For devices with an exposed pad (e.g., QFN), the exposed pad surfaces shall exhibit a continuous solder coating free from defects for a minimum of 80 percent of the critical area of those surfaces.
- e. Wetting angle shall be less than or equal to 90 degrees.

5.8.2 Evaluation of devices with solder terminals. The criteria for acceptable solderability shall be as follows:

- a. Ninety-five percent of the total length of the fillet, between the standard wrapping wire and the solder terminal, is tangent to the surface of the solder terminal being tested and free from pinholes, voids, porosity, nonwetting or dewetting.
- b. A non-uniform flow line where the solder fillet joins with the surface of the solder terminal may occur from the method of solder application and is acceptable providing wetting is as specified in 'a' above.

6. Summary. The following details should be specified in the applicable procurement document:

- a. When using parameters other than those specified as default for the applicable test condition:
 - (1) For test condition D.
 - i. The angle of immersion, if other than specified (see 5.5.1.3.3)
 - ii. The depth of immersion, if other than specified (see 5.5.1.3.4).
 - (2) For test condition H.
 - i. The type of flux to be used, if other than specified (see 4.2.2).
 - ii. The composition of solder, solder ribbon or solder wire to be used, if applicable (see 4.2.3.3).
 - (3) For test condition S.
 - i. The stencil thickness, if other than specified (see 4.1.3)
 - ii. The solder paste composition, if other than specified (see 4.2.2).
 - iii. The substrate material, if other than specified (see 4.2.5).
 - iv. The reflow soldering profile, if other than specified (see 4.3.1.1).
- b. The terminal finish precondition category letter (see 2.2).
- c. The number of terminals to be tested, if other than 22 (see 5.2).
- d. The number of devices to be tested, if other than 3 (see 5.2).
- e. Special preparation of the terminals, if other than specified (see 5.3.3).
- f. Solder composition, flux composition, and soldering temperature, if other than those specified (see 4.2.2, 4.2.4 and 4.3.1).
- g. Examination magnification, if other than specified (see 5.7).
- h. Customer/device manufacturer special cleaning requirements (see 5.6.2).
- i. Customer/device manufacturer requirements for critical zone acceptance criteria (see 5.7.5).



FIGURE 2026-1 . Pinholes.

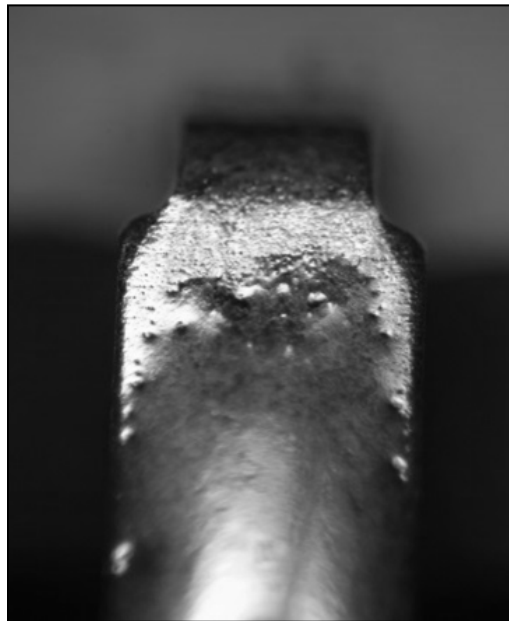


FIGURE 2026-2. Dewetting.

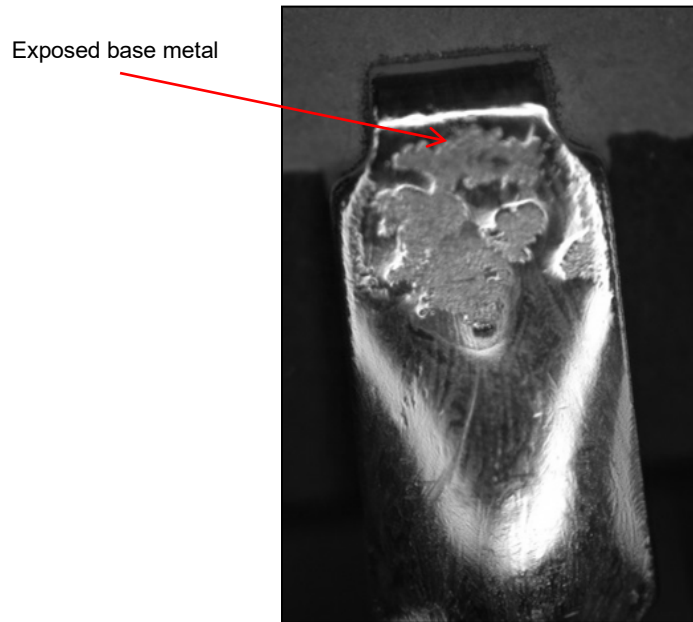
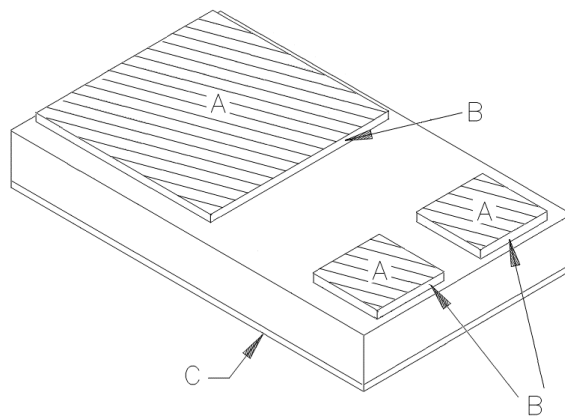


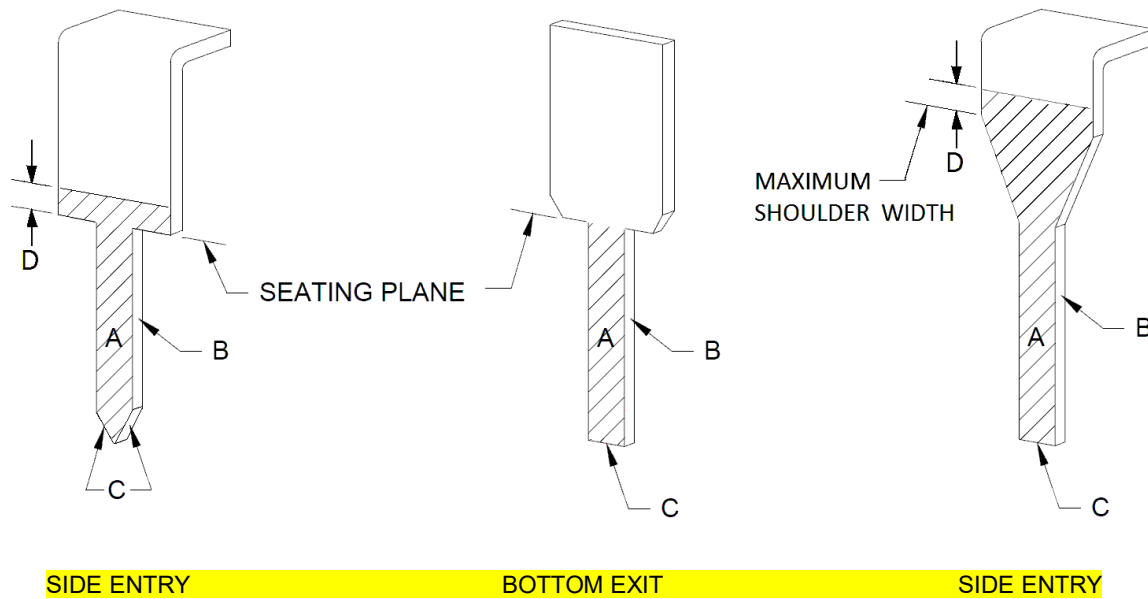
FIGURE 2026-3. Non-wetting.



NOTES:

- a. Critical area = surfaces "A" and "B".
- b. Surface "C" (topside of package) is excluded.

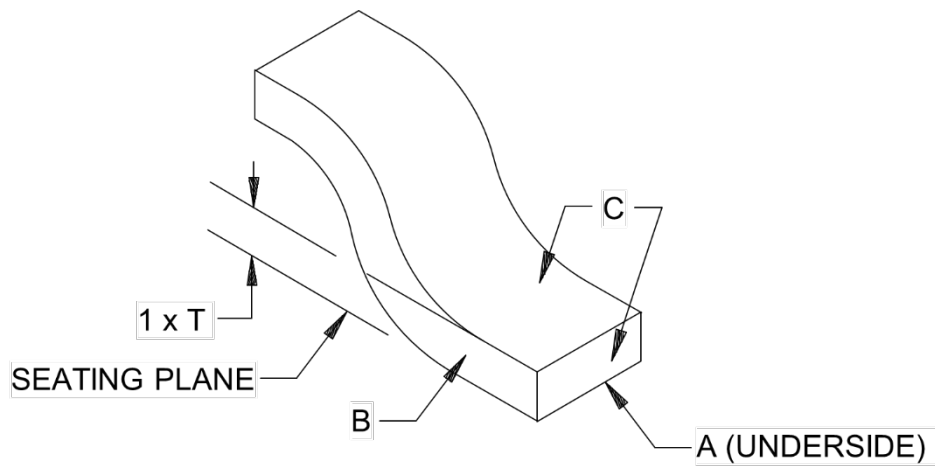
FIGURE 2026-4. Critical area for SMD packages with bottom pad terminals.



NOTES:

- Critical area = surfaces "A" and edges "B".
- Surfaces "C" (bottom and cut sides) are excluded.
- Dimension D = .02 inch (0.51 mm) above seating plane or point of maximum shoulder width.

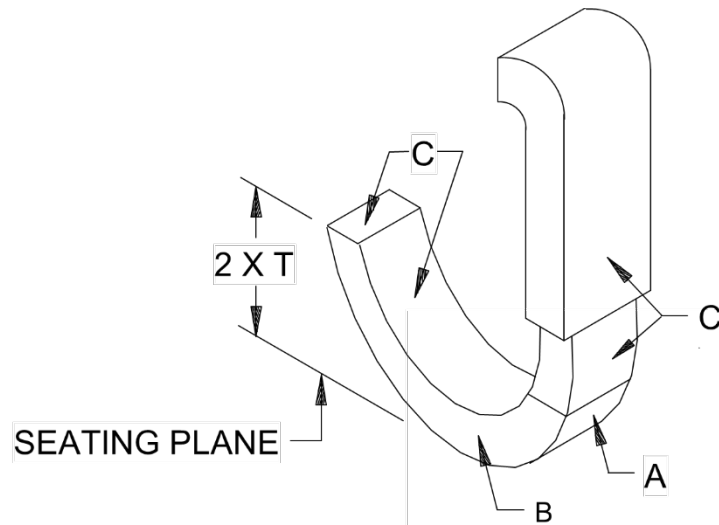
FIGURE 2026-5. Critical area for dual-in line package terminals.



NOTES:

- Critical area = surfaces "A" (up to 1 x lead thickness) and edges "B".
- Surface "C" is excluded.

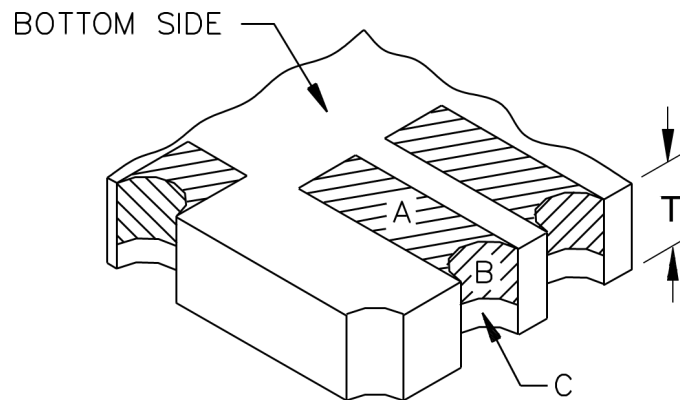
FIGURE 2026-6. Critical area for gull wing terminals.



NOTES:

- Critical area = surfaces "A" and edges "B" within the 2x lead thickness (T) zone.
- Surfaces "C" are excluded.

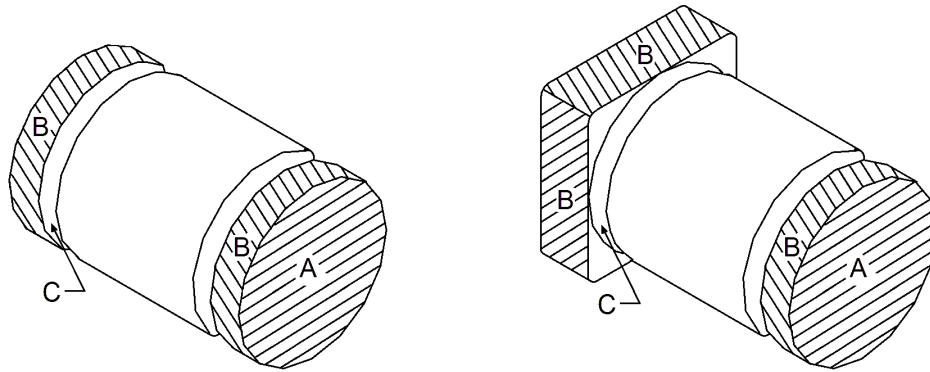
FIGURE 2026-7. Critical area for J-lead terminals.



NOTES:

- Critical area = surfaces "A" and "B". "B" = $\frac{2}{3}$ of "T".
- Surface "C" is excluded.

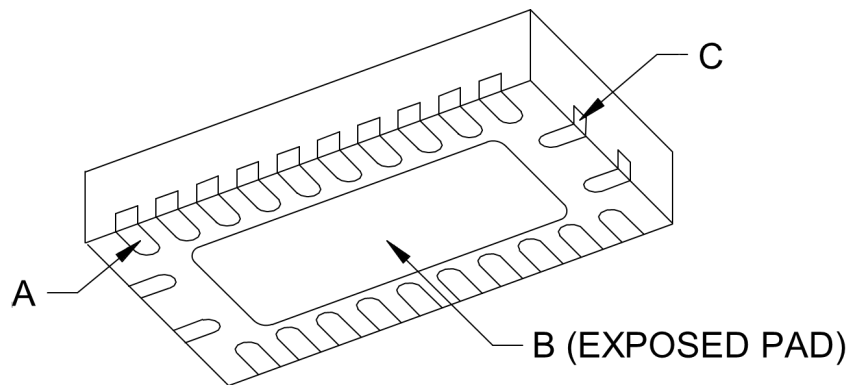
FIGURE 2003-8. Critical area for terminals of leadless chip carrier packages.



NOTES:

- a. Critical area = surfaces "A" and "B".
- b. Surface "C" is excluded.
- c. Package type DO-213 shown.

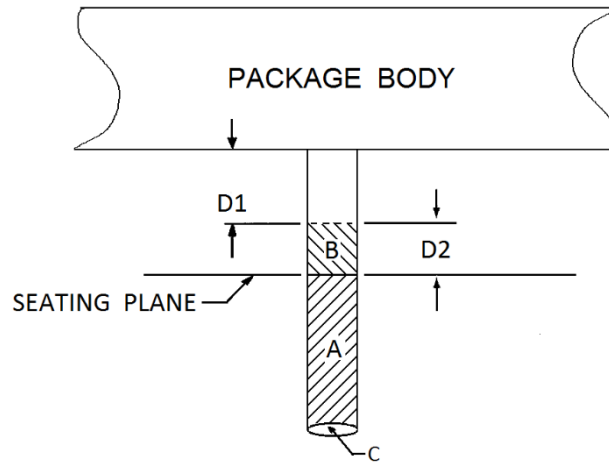
FIGURE 2026-9. Critical area for terminals of MELF (UR, US and URS) packages.



NOTES:

- a. Critical area = surfaces "A" and "B".
- b. Surface "C" is excluded.

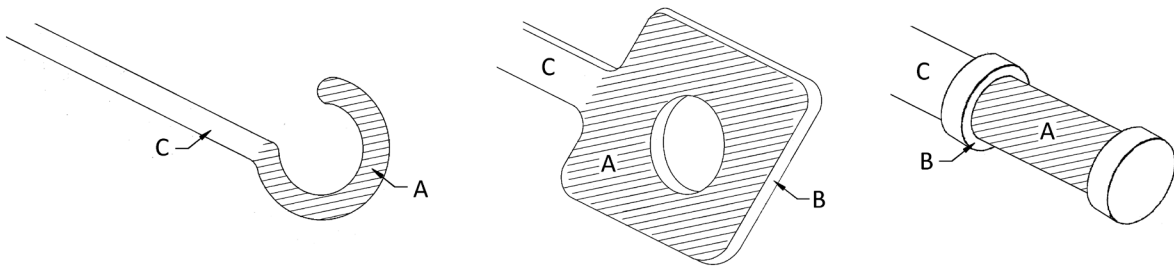
FIGURE 2026-10. Critical area for QFNs.



NOTES:

- Critical area = surfaces "A" and "B". Surface "B" includes the area above the seating plane that is within .050 inch (1.27 mm) of the bottom of the package body (dimension D1) or .030 inch (0.76 mm) above seating plane (dimension D2), whichever is the lesser distance.
- Surface "C" is excluded.

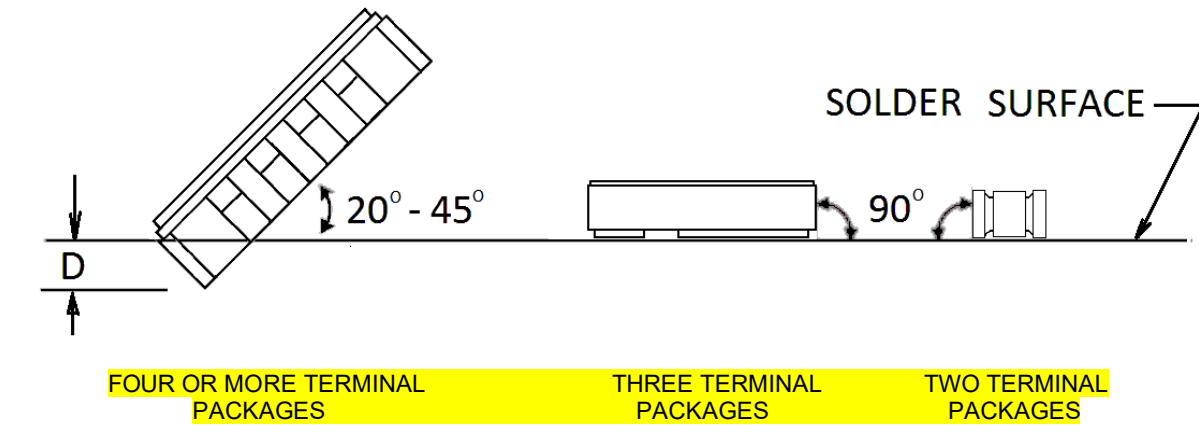
FIGURE 2026-11. Critical area for round-lead terminals.



NOTES:

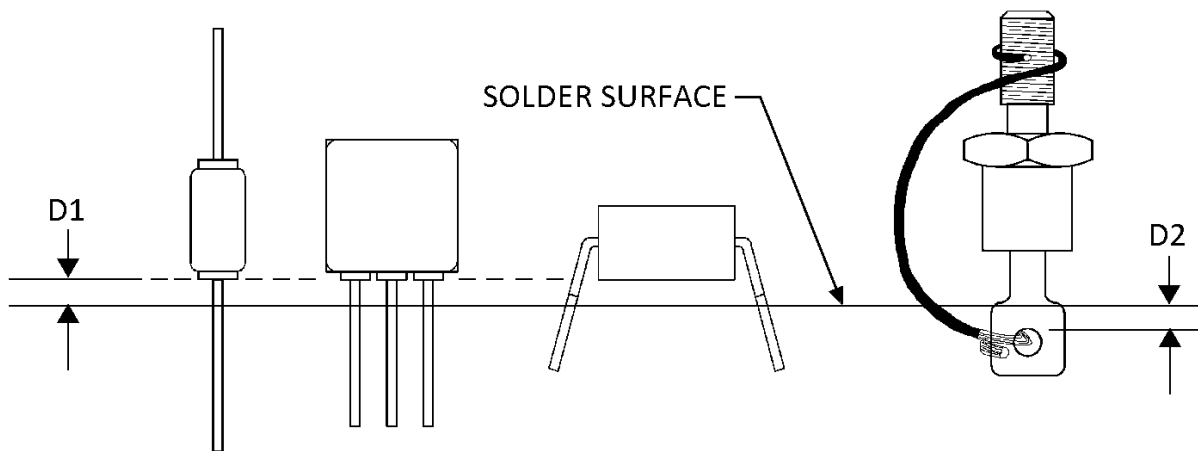
- Critical area = surfaces "A" and "B".
- Surface "C" is excluded.

FIGURE 2026-12. Critical area for solder terminals.



NOTE: Dimension D is .004 inch (0.10 mm).

FIGURE 2026-13. Dipping angle for SMD packages.



NOTES:

- a. Dimension D1 is .05 inch (12.7 mm) above the surface of the molten solder.
- b. Dimension D2 is .05 inch (12.7 mm) below the surface of the molten solder.

FIGURE 2026-14. Dipping depth for through hole mount packages

ATTACHMENT 2

METHOD 2026.40 13

SOLDERABILITY

1. **Purpose.** The purpose of this test method is to provide a referee condition for the evaluation of the solderability of termination leads, pads, pins and solder terminals (including leads up to 0.125 inch in diameter hereafter referred to as 'terminals') of semiconductor devices that will be assembled using tin-lead eutectic solder (hereafter referred to as 'solder'). This evaluation is made on the basis of the ability of these termination terminals to be wetted and to produce a suitable fillet when coated by tin-lead eutectic solder.

2. **APPARATUS. Overview.** This test method describes three solderability test conditions by which terminals may be evaluated for solderability. These procedures will test conditions can be used to determine whether the packaging materials and processes used during the manufacturing operations produce a device that can be successfully soldered to the next level of assembly using tin-lead eutectic solder. A. Two different terminal finish preconditioning test is procedures are included in this test method. The purpose of these preconditioning procedures are to which degrades the termination terminal finish to provide a guard band against marginal terminal finishes.

2.1 Test conditions.

2.1.1 Covered herein. The three solderability test conditions detailed in of this test method are as follows:

- a. Test condition D is a dip soldering procedure. The procedure of this test condition can be used on leaded and leadless devices.
- b. Test condition H is a hand soldering procedure. The procedure of this test condition assembles standard wrapped wire onto devices with solder terminals.
- c. Test condition S is a reflow soldering surface mount simulation procedure. The procedure of this optional test condition simulates the assembly of the surface mount device (SMD) to a non-wetting substrate.

2.1.2 Covered by other documents. The test conditions covered by non-Government standard test methods are addressed by MIL-STD-202-208 as follows:

- a. Test A. For through hole mount and surface mount leaded components with terminals less than .045 inch (1.14 mm) in diameter.
- b. Test B. For surface mount leadless components.
- c. Test C. For solder terminals and terminal greater than .045 inch (1.14 mm) diameter.

2.2 4.2 Terminal finish preconditioning categories. The terminal finish preconditioning categories shall be are as follows:

- a. Category A: This category is intended to be used on all device terminal finishes which have no Gold or Tin content specified (steam for 1 hour ±5 minutes).
- b. Category C: This category is intended for all other device terminal finishes, including those containing Gold and Tin (steam for 8 hours ± 15 minutes).
- c. Category D E: For LGAs This category is intended to be used on all device terminal finishes, including those containing Gold and Tin (dry-bake for 4 hours ± 15 minutes).

2.3 Test classification. Solderability testing of devices is classified as a destructive test.

3. ~~1.1 Terms and Definitions.~~ The definition of terms shall be in accordance with the following:

3.1 Terms used in this test method. The definitions of terms used in this test method are specified in MIL-PRF-19500 and herein.

3.1.1 ~~3-1 Foreign material.~~ Particles of material located on, but different from, the lead terminal material or coating terminal finish.

3.1.2 ~~3-5 Pinholes (see figure 2026-1).~~ Holes occurring as imperfections that penetrate entirely through the solder layer. An imperfection in the form of a small hole that penetrates through a layer of material.

3.1.3 ~~3-4 Solderability.~~ The ability of a metal to be wetted by molten solder.

3.1.4 Terminal. A metallic device that is used for making electrical connections. Terminals includes component leads, pads, pins and solder terminals up to .125 inch (3.18 mm) in diameter.

3.1.4.1 Leaded through hole mount. The electrical connection of components to a conductive pattern by the use of component holes. Examples of leaded through hole mount packages used on MIL-PRF-19500 specification sheets includes axial, DIPs, certain DO and TO cans.

3.1.4.2 Leaded surface mount. A surface-mount component for which external connections consist of terminals that are around and down the side of the package. Examples of leaded surface mount devices used on MIL-PRF-19500 specification sheets include Button-Tab, SOT-23, ThinKey, and U2L.

3.1.4.3 Leadless surface mount. A surface-mount component whose external connections consist of metallized terminals that are an integral part of the component body. Examples of leadless surface mount devices used on MIL-PRF-19500 specification sheets include LCC, U, UA, and U5.

3.1.4.4 Radial leaded. A component where the terminals are located on the bottom, radially and parallel to the central axis. Examples of radial leaded packages used on MIL-PRF-19500 specification sheets include TO-3, TO-78, and TO-205AA.

3.1.4.5 Solder terminal. An electrical-mechanical connection surface that is used to terminate a discrete wire or wires by soldering. Types included are bifurcated, cup, hook, perforated and turret style solder terminals. Examples of solder terminal packages used on MIL-PRF-19500 specifications sheets include DO-4, TO-61 and TO-63.

3.1.5 ~~3-3 Wetting.~~ The formation of a relatively uniform, smooth, and unbroken and adherent film of solder, adherent to the surface of the base metal tested.

3.1.5.1 ~~3-2-1 Dewetting (see figure 2026-2).~~ A condition that results when molten solder has coated a surface and then receded leaving irregularly shaped mounds of solder separated by areas covered with a thin-solder film of solder and where with the base metal is not exposed.

3.1.5.2 ~~3-2-2 Nonwetting (see figure 2026-3).~~ A condition whereby a surface has contacted molten solder, but the solder has not adhered to all of the surface, leaving the surface base metal partially or totally exposed.

3.1.6 Critical area. The critical areas of a terminal are those areas identified that shall be covered with solder and complies with the minimum acceptance limits after solderability testing.

3.2 Acronyms used in this test method. The acronyms used in this test method are as follows.

3.2.1 1.1.7 DIP. Dual In-line Package.

3.2.2 DO. Diode-Outline.

3.2.3 1.1.8 TO. Transistor-Outline.

3.2.4 1.1.14 LCC. Leadless Chip Carrier.

3.2.5 MELF. Metal Electrode Leadless Face.

3.2.6 QFN. Quad Flat No-leads.

3.2.7 SMD. Surface mount device.

3.2.8 UR. Unleaded Round.

3.2.9 URS. Unleaded Round Square.

3.2.10 DUT. Device under test.

3.2.11 IR. Infra-red.

4. PROCEDURE General requirements.

4.1 Apparatus. Not all equipment listed below is applicable or required for each test condition.

4.1.1 Apparatus for test condition D (dip soldering procedure).

4.1.1.1 2.2 Dipping mechanism. ~~A~~ The dipping mechanism shall be capable of controlling the rates of immersion and emersion of the ~~terminations~~ terminals and ~~providing~~ provide a dwell time (total time at the required depth) in the solder bath as specified in 5.5.1. The dipping mechanism shall be also capable of orienting and dipping the terminals of the device to meet the dipping immersion angle requirements specified in 5.5.1. The ~~specimen~~ device holder of the dipping mechanism shall be designed to minimize the trapping of flux.

4.1.1.2 2.4 Solder pot bath. ~~A~~ The solder bath shall be a thermostatically controlled ~~static-solder~~ vessel of sufficient size to contain at least two pounds (0.9 Kg) of solder. The molten solder shall be static during the dipping procedure. The ~~apparatus~~ solder bath shall be capable of maintaining the solder at the temperature specified in 4.3.1.

4.1.2 Apparatus for test condition H (hand soldering procedure).

4.1.2.1 2.5 Soldering iron. The soldering iron shall be a conduction temperature controlled ~~solder-iron~~ apparatus capable of appropriate thermal capacity adequate to allow the solder connection to be made solidly and maintain proper soldering temperature throughout the soldering operation.

4.1.2.2 Fixture. Fixtures, when required, shall be made of a non-solderable material designed so that they will make minimum contact (i.e., minimum heat sink) with the DUT or DUT assembly.

4.1.3 Apparatus for test condition S (reflow soldering surface mount simulation procedure). Alternative automated solder paste dispensing systems (e.g., jet printing) may be used that do not require the use of a stencil, base fixture or squeegee.

4.1.3.1 2-5 Screen print Stencil. ~~A~~ The stencil used to screen print solder paste shall be metal (or other acceptable material (such as plastic) ~~stencil~~ with pad geometry openings appropriate for the device being tested. ~~Alternative dispense systems may be used that do not use a stencil or squeegee (e.g., jet printing).~~ Unless otherwise specified, the nominal stencil thickness shall be as follow:

- a. For devices with a lead pitch < .020 inch (0.51 mm): .004 inch (0.10 mm).
- b. For devices with a lead pitch ≥ .020 inch (0.51 mm) and up to .025 inch (0.635 mm): .006 inch (0.15 mm).
- c. For devices with a lead pitch > .025 inch (0.635 mm): .008 inch (0.20 mm).

4.1.3.2 2-6 Squeegee. The squeegee shall be a rubber, plastic, or metal tool used to print the solder paste. ~~This is not applicable if alternative dispense systems (e.g., jet printing) are used.~~

4.1.3.3 2-7 Base fixture. The base fixture shall be ~~a fixture~~ designed to hold the substrate and aid in the alignment of the ~~screen print~~ stencil.

4.1.3.4 2-8 Reflow soldering equipment. The equipment used for reflow soldering shall be a ~~forced-convection reflow oven or equivalent reflow~~ system capable of achieving the specified (see 5.5.3) or recommended (see 6.a.3) reflow soldering profile.

4.1.4 Apparatus for device terminal preconditioning.

4.1.4.1 2-12 Steamaging ~~Steam preconditioning~~ equipment. The steam preconditioning equipment shall consist of a chamber, accessories and fixtures needed for holding the devices undergoing steam preconditioning. The steam preconditioning equipment shall be constructed of a corrosion resistant and non-contaminating material. The steam preconditioning equipment shall be capable of continuously maintaining the devices undergoing preconditioning at the parameters specified in 5.4. ~~A non-corrodible container and cover of sufficient size to allow the placement of devices inside the vessel. A suitable method of supporting the devices shall be improvised using non-contaminating material. The devices shall be placed such that the lowest portion of the device is a minimum of 1.5 inch above the surface of the water.~~ The apparatus equipment shall be capable of having the specified temperature verified.

4.1.4.2 2-13 High-temperature Dry bake ~~preconditioning~~ equipment. The dry bake preconditioning equipment shall consist of an oven, accessories and fixtures needed for holding the devices undergoing dry bake preconditioning. The ~~A bake~~ oven shall be of sufficient size and capable of continuously maintaining the devices undergoing preconditioning at 150°C ±5°C. Temperature control shall be used. The equipment shall be capable of having the specified temperature verified.

4.1.4.3 Drying oven. The oven used for baking moisture out of the devices shall be capable of maintaining a set temperature within the range of 85°C to 115°C.

4.1.5 2-14 Lighting equipment. The lighting equipment to be used for visual inspection shall be a ~~lighting~~ system that will provide a uniform, non-glare, non-directional illumination of the device.

4.1.6 2-10 Optical equipment. The optical equipment to be used for visual inspection shall be a stereo optical system capable of providing a minimum magnification of ~~40x~~ that required for post-test terminal inspection (see 5.7). The optical system shall be equipped with reticles, or equivalent, for taking measurements.

4.1.7 Storage chamber. The chamber used for storing devices between their preparation and testing shall be a desiccant jar, dry nitrogen cabinet, or other suitable chamber.

4.1.8 Temperature measurement apparatus. The temperature measurement apparatus shall be a thermocouple or other suitable devices that can be used to measure the oven, solder, or vapor temperature.

4.1.9 Timing apparatus. When applicable, timing equipment which can indicate time in seconds shall be used to determine the time in which the DUT is exposed to molten solder or temperatures of the reflow soldering chambers. The timing equipment shall be automated and accurate to the limits of the test condition or procedure used.

4.2 3 Materials. Unless otherwise specified, all chemicals shall be of commercial grade or better. ~~Fresh solvents should be used as often as is necessary to preclude contamination.~~

WARNING: These materials may involve substances that are flammable, toxic to eyes, skin, or respiratory tract, or present a serious burn potential. Eye and skin protection should be used. ~~Heat-resistant gloves should be used when handling hot objects.~~

4.2.1 3.4 Cleaning solution. The cleaning solutions (e.g. isopropyl alcohol) used for flux residue removal after the solderability test shall be compatible with the device ~~and the metal-clad substrate.~~ Fresh cleaning solutions should be used as often as is necessary to preclude contamination.

~~3.5 Isopropyl alcohol. Commercial-grade isopropyl alcohol or better.~~

4.2.2 3.1 Flux.

4.2.2.1 Standard testing flux. The standard testing flux shall be ~~a standard an~~ activated rosin flux having a composition of 25 percent ± 0.5 percent by weight of Colophony (rosin) and 0.15 percent ± 0.01 percent by weight Diethylamine Hydrochloride (CAS 660-68-4), in 74.85 percent ± 0.05 percent by weight of Isopropyl Alcohol.

4.2.2.2 Alternate testing flux. When specified, low activity fluxes conforming to ROL0 or ROL1 may be substituted for the standard testing flux.

4.2.2.3 Maintenance. The flux shall be kept at ambient room temperature when in use and shall be covered when not in use. Once put into use, the flux shall be discarded after eight hours. Alternatively, if the standard testing flux can be maintained to a specific gravity of 0.843 ± 0.005 at $25 \pm 2^\circ\text{C}$, it can be used for a maximum of 7 days before being discarded.

4.2.3 Solders.

4.2.3.1 3.2 Solder. The solder shall ~~conform to type~~ be alloy composition Sn63Pb37, Sn60Pb40, or equivalent. The tin content of the solder shall be maintained within ± 1 percent of the nominal alloy being used.

4.2.3.2 3.3 Solder paste. The solder paste shall be alloy composition Sn60Pb40, Sn63Pb37, or equivalent, ~~with mesh size of -325/+500~~, flux type ROL1. The solder paste shall meet the shelf life and storage conditions ~~and shelf life~~ shall be in accordance with the solder paste manufacturer's requirements ~~of the manufacturer's specification.~~

4.2.3.3 Solder ribbon or wire (test condition H only). When applicable, the solder ribbon or wire alloy shall be in accordance with 4.2.3.1. If applicable, the flux of fluxed-core solder ribbon or wire shall be in accordance with 4.2.2.

4.2.4 3.4 Standard copper wrapping wire (test condition H only). The standard wrapping wire ~~specified in 4.4.3~~ shall be fabricated from type S H, class S, ~~soft or drawn and~~ annealed, uncoated in accordance with QQ-W-343 A-A-59551, Wire, Electrical ~~and Nonelectrical~~, Copper (Uninsulated). The diameter of the ~~standard~~ wrapping wire shall be $.025 \pm .005$ inch ($0.635 \text{ mm} \pm 0.13 \text{ mm}$).

4.2.5 Substrate (test condition S only). Unless otherwise specified, the non-wetting substrate used for the reflow soldering surface mount simulation procedure shall be ceramic. The typical thickness of the substrate should be from .025 to .035 inch (0.635 mm to 0.889 mm). Substrates constructed of other non-wettable materials may be used when specified (see 6.a.3). ~~2.3 Ceramic substrate. A thin unmetallized ceramic substrate with a thickness range of 0.025 inch to 0.035 inch (used for testing of ball grid arrays). 2.4 Metallized substrate. A substrate made of glass-reinforced epoxy (e.g., FR-4) with metallized pads (e.g., Electroless Nickel Immersion Gold). The pad diameter shall be at least 0.010 inch larger than the column diameter (used for testing of column grid arrays).~~

4.2.6 ~~3.6~~ Water. The water ~~to be~~ used for steam preconditioning purposes shall be either distilled or deionized.

4.3 Soldering temperatures and solder composition maintenance.

4.3.1 Soldering temperatures.

4.3.1.1 Reflow soldering chambers. The reflow soldering chamber shall be capable of generating the environments (heating rates, temperatures, etc.) in accordance with table 2026-I or as specified (see 6.a.3). The reflow soldering equipment shall be capable of maintaining an accuracy of $\pm 1^{\circ}\text{C}$ at the temperature range of interest.

4.3.1.2 Solder bath. The solder bath shall be capable of maintaining the solder at a uniform temperature of 245°C ($473^{\circ}\text{F} \pm 9^{\circ}\text{F}$).

TABLE III 2026-I. Reflow soldering parameter requirements.

Method	Peak temperature ($^{\circ}\text{C}$)	Time (above 183°C)
Vapor phase reflow	215 – 219	30 – 90 seconds dwell at reflow
IR reflow or forced-air convection reflow	150 – 170 preheat	50 – 70 seconds
	200 – 230 reflow	50 – 70 ~~60–120~~ seconds
Storage oven reflow	215 – 230	2 – 5 minutes (until reflow is assured)

NOTE: Table 2026-I reflow parameter values are for solderability testing purposes only and are not related to moisture sensitivity level reflow test parameters. These reflow soldering parameters refer to measurements taken on the device body.

4.3.1.3 Soldering iron.

4.3.2 Temperature measurements.

4.3.2.1 Reflow soldering chamber. Low mass thermocouples that do not affect the heating rate of the DUT shall be used. A temperature recording device is recommended.

4.3.2.2 Solder bath. A thermocouple or other suitable devices shall be used to measure the solder temperature. The solder bath temperature shall be measured in the center of the bath at a depth of at least .750 inch (20 mm), but no deeper than 1 inch (25 mm) below the surface of the solder.

~~4.4.1.2.3 Solder bath contaminants. The manufacturer shall have a system to verify that the solder bath does not exceed the contaminant levels specified in table 2003-III.~~

4.3.3 Solder bath maintenance.

4.3.3.1 Solder composition and contaminants. The composition of the solder, including level of contaminants, shall be monitored and maintained. The solder bath shall be analyzed (either chemically or spectrographically) or replaced after 30 operating days as a minimum. An operating day consists of any eight-hour period, or any portion thereof, during which the solder is liquefied. A procedure shall be developed, documented, and implemented demonstrating that the solder composition and levels of solder contamination remains in control.

4.3.3.2 Control of solder contamination. The levels of solder contamination shall be within those shown in table 2026-II. If contamination of the solder bath exceeds the limits specified in table 2026-II, then the solder shall be changed and the intervals between analysis shall be shortened. The intervals between analysis may be lengthened if the analysis results indicate that the levels of contamination limits are not being approached.

TABLE 2026–II. Solder bath contaminant limits (see 4.4.1.2.3).

Contaminant	Maximum contaminant weight percentage limit	Contaminant	Maximum contaminant weight percentage limit
Aluminum (Al)	0.006 1/	Gold (Au)	0.200 1/
Antimony (Sb)	0.500	Iron (Fe)	0.020
Arsenic (As)	0.030	Nickel (Ni)	0.010
Bismuth (Bi)	0.250	Silver (Ag)	0.100
Cadmium (Cd)	0.005 1/	Zinc (Zn)	0.005 1/
Copper (Cu)	0.300 1/		

NOTE: 1/ The total of Aluminum, Cadmium, Copper, Gold, and Zinc contaminants shall not exceed 0.4 percent.

4.3.3.3 **Tin content.** The Tin (Sn) content of the solder bath shall be maintained within ± 1.0 percent of the nominal solder alloy being used. The Tin content shall be tested at the same frequency as testing for Copper (Cu) and Gold (Au) contamination. The balance of the solder bath shall be Lead (Pb) and the other elements listed in table 2026–II.

4.4 **Procedures of test conditions covered by external test methods.** When specified, the procedures for solderability test conditions covered by external test methods shall be performed in accordance with the current revision of MIL–STD–202–208.

5. ~~SUMMARY.~~ Detailed requirements.

WARNING: Heat resistant gloves should be used when handling hot objects.

5.1 Test condition procedure operations. The ~~test~~ **entire** procedure **for each solderability test condition** shall consist of the following operations:

- a. **Selection of terminals to be tested (see 5.2).**
- b. **Proper** Preparation of the ~~specimens~~ **terminals or wrapping wire** (see ~~4.1~~ **5.3**), if applicable.
- c. Preconditioning of ~~all specimens~~ **the terminals** (see ~~4.2~~ **5.4**).
- d. Solderability test **procedure** (see ~~4.4~~ **5.5**).
- e. **Post-test removal of residual flux from the terminals (see 5.6).**
- f. Examination and evaluation of the tested portions of the ~~terminations~~ **terminals upon completion of the solder-dip process** (see ~~4.5~~ **5.7**).

5.2 Sampling. ~~4. Procedure.~~ The test procedure shall be performed on the number of ~~terminations~~ **terminals** specified in the **performance specification or** acquisition document. If no ~~number~~ **sample size** is specified, then the sample size shall be ~~22(0)~~ **terminals with no failures**. The ~~samples~~ **terminals to be tested** shall be selected at random from at least 3 different devices. The **solderability test procedure** may be performed just prior to packaging for storage or shipment, immediately upon removal from the manufacturer's protective packaging, or as a qualification or conformance inspection. ~~During handling, special care shall be exercised to prevent the surfaces being tested from being abraded or contaminated by grease, perspiration, or abnormal atmospheres.~~

5.3 Preparation of terminals and standard wrapping wire.

5.3.1 4.1 Preparation of termination terminals. The devices shall be handled in such a manner as to prevent the terminals to be tested from being contaminated by abnormal atmospheres, grease, or perspiration. The terminals to be tested shall not be abraded, cleaned, scraped, or wiped prior to testing.

5.3.2 3.4 Preparation of standard wrapping wire (test condition H only). The preparation of the **standard** wrapping wire shall be as follow:

- a. Straighten and cut wire into convenient lengths. **A minimum length of (2 inches (50.80 mm) minimum) is recommended.**
- b. Clean or degrease as necessary to ensure the wire surface is free of contaminants.
- c. Immerse **wire** in flux.
- d. Dip **wire** in molten solder for 5 seconds **at +245°C ±5°C (+473°F ±9°F).**
- e. **Rinse or wash wire in cleaning solution** to remove or dissolve the residual flux ~~wash or rinse in isopropyl alcohol.~~

Standard wrapping wire shall 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 solder coating.**

5.3.3 4.1 Special preparation of **termination terminals**. Any special preparation of the **termination terminals**, such as bending or reorientation prior to the **solderability** test, shall be **as** specified in the **performance specification** or acquisition document (see 6.e).

5.4 4.2 **Terminal finish preconditioning**. The **terminal finish** preconditioning categories shall be as **follows** specified in table 2026–III.

TABLE 2026–III. **Terminal finish preconditioning parameters.**

Category	Precondition	Exposure time	Applicability by finish	Use
A	Steam	1 hour ±5 minutes	For non-Gold and non-Tin alloy finishes.	When specified
C	Steam	8 hours ±15 minutes	All terminal finishes	When specified
E	Dry bake	4 hours ±15 minutes	All terminal finishes	Default

5.4.1 4.2.1 **Steam aging preconditioning (categories A and C).**

5.4.1.1 **General**. Prior to the application of the flux and subsequent **solder-dips solderability testing**, **specimens** devices to be tested designated as precondition category A or C shall be subjected to **aging by exposure of the surfaces to be tested to water vapor (see 4.2) in the apparatus specified in 2.12 steam preconditioning for the exposure time applicable for the category.**

5.4.1.2 **Procedure**. When devices are being exposed to steam in the steam preconditioning chamber, the following details shall apply:

- The **water-vapor steam** temperature at the **device-lead terminal** level shall be in accordance with table 2026–IV.
- The steam preconditioning **aging** may be interrupted once for 10 minutes maximum.
- The devices shall be suspended so that no portion of the device is less than 1.5 inches (38 mm) above the boiling water.
- The devices shall be placed so that no device has its terminals touching any other device or the steam preconditioning chamber.
- The devices shall be arranged in such a manner as to avoid condensate dripping on the devices undergoing preconditioning.
- When possible, the devices shall be placed with their terminals facing up ("dead-bug" orientation).

The devices shall be removed from the **apparatus steam preconditioning chamber** upon completion of the **specified test period** exposure time specified in table 2026–III.

TABLE 2026–IV. **Altitude versus steam temperature (see 4.2.1).**

Altitude (feet)	Average boiling point (°C)	Steam temperature (+/-3°C)
0 - 1,000	100	93
1,001 - 2,000	99	92
2,001 - 3,000	98	91
3,001 - 4,000	97	90
4,001 - 5,000	96	89
5,001 - 6,000	95	88
Greater than 6,000	95	87

5.4.1.3 4.2.1.1 Post steam preconditioning drying and storage procedures. Upon removal of test specimens devices from the steaming apparatus following steam preconditioning chamber, the devices shall be dried (if applicable) using one of these two following procedures:

- a. Air dry at ambient temperature for a minimum of 15 minutes.
- b. Bake at 100°C maximum for no more than 1 hour in a dry atmosphere. A (dry nitrogen atmosphere is recommended).

5.4.1.4 2.12.1 Cleaning of the system. The steam preconditioning chamber apparatus shall be drained and cleaned at least once per each month or prior to use. A more frequent cleaning cycle may be necessary as indicated by resistivity, visual, or general cleanliness of the water. No contaminating solvents shall be used to clean the chamber, accessories and fixtures.

5.4.2 4.2.2 Dry bake preconditioning (category E).

5.4.2.1 General. (Category-D) Prior to the application of the flux and subsequent solder-dips solderability testing, specimens devices designated as precondition category E shall be subjected to aging by exposure of the surfaces to be tested to high temperature (see 4.2) in the apparatus specified in 2.13 dry-bake preconditioning.

5.4.2.2 Procedure. The devices to be tested shall be placed in the chamber and subjected to dry-bake preconditioning for the time period specified in table 2026–III. Dry-bake preconditioning Aging may be interrupted once for 10 minutes maximum. The devices shall be removed from the test apparatus dry-bake preconditioning chamber upon completion of the specified time period specified in table 2026–III.

5.4.3 4.3 Post preconditioning storage requirements. If solderability testing cannot be performed within 2 hours after preconditioning, then the devices shall be stored in a low humidity environment (desiccant jar or dry nitrogen cabinet).

5.4.4 Post preconditioning dwell time. If solderability testing must cannot be performed on the devices within 72 hours after removal from the preconditioning equipment, either a new sample of devices shall be preconditioned or the existing sampled devices shall be re-submitted to preconditioning.

5.5 4.4 Solderability test conditions. The test is divided into two methods: Dip and Look and BGA/CGA Surface Mount Simulation.

5.5.1 4.4.1 Test condition D (dip soldering procedure). The dip soldering procedure can be used to test dip and look test shall be performed on the following devices packages:

- a. Leaded through hole mount (e.g., DIP, TO-can, PGA).
- b. Leaded surface mount (e.g., J-lead, QFP).
- c. Leadless surface mount (e.g., LCC, LGA, QFN).

5.5.1.1 4.4.1.1 Application of flux. The termination to be tested shall be immersed in flux maintained at room ambient temperature. The critical area of the termination terminal (see figures 2026–4 through 2026–12) to be tested shall be immersed in the flux for 5 to 10 seconds, and shall be drained for 5 to 20 seconds prior to dipping in the solder pot bath. The flux shall be covered when not in use and discarded a minimum of once a day. Any obvious droplets of flux clinging to the termination terminals may be removed by blotting.

5.5.1.2 4.4.1.2 Solder dipping Preparation of solder bath before testing. The dross and burned flux shall be skimmed from the surface of the molten solder prior to testing. A wave soldering pot apparatus may be used for this purpose, but the solder shall be static during the dipping procedure (skimming may not be required in wave or flow pots). The molten solder shall be at a uniform temperature of 245°C ±5°C (473°F ±9°F).

5.5.1.3 Solder dipping. The device shall be attached to a the dipping mechanism (see 2.2 4.1.1.1) and the flux covered termination terminals immersed once ~~(except for the possible duplicate immersion of corner termination on leadless surface mount devices)~~ in the molten solder at the dipping rate, dwell time, immersion angle, depth, and for the number of cycles specified. The following details apply:

- a. **4.4.1.1.1 Axial and SMDs (leaded and leadless) packages surface mount devices.** Perform the dip soldering test on the termination terminals on one side of the device at a time. The fluxing and solder dipping operations shall be performed sequentially on the termination terminals of the side under test.
- b. **Bottom pad SMD, radial, and solder terminal packages.** The fluxing then dip soldering operations shall be performed sequentially on all terminals undergoing testing.

5.5.1.3.1 Dipping (immersion and emersion) rate. The immersion and emersion rates shall be 1.0 inch $\pm$.250 inch (25.4 mm $\pm$ 6.35 mm) per second.

5.5.1.3.2 Dwell time. The test specimen device shall not be suspended above the hot molten solder pot for longer than 7 seconds. ~~The immersion and emersion rates shall be 1.0 inch per second $\pm$.250 inch per second.~~ The dwell time in the solder shall be as follows:

- a. **For terminals less than .040 inch (1.02 mm) in diameter:** 5 seconds $\pm$ 0.5 second.
- b. ~~The dwell time for termination~~ **For terminals** greater than or equal to .040 inch (1.02 mm) in diameter: shall be 7 seconds $\pm$ 0.5 second.

After the solder dipping process, the device shall be allowed to cool in air. ~~Residual flux shall be removed from the terminations by dipping the devices in isopropyl alcohol or other suitable solvent. If necessary, a clean soft cloth, cotton swab, or equivalent, moistened with clean isopropyl alcohol or other suitable solvent, may be used to remove all remaining flux.~~

5.5.1.3.3 4.4.1.2.2 Immersion angle (see figure 2026–13). Unless otherwise specified, the termination angle at which terminals are shall be immersed into the solder surface shall be as follows:

- a. **Leaded through hole mount:** ~~(e.g., DIP, TO can, PGA)~~ 90°
- b. **Leaded and leadless surface mount with 3 or less terminals:** ~~(e.g., J-lead, QFP) 20° to 45° (or 90°)~~
- c. **Leadless and leadless surface mount with 4 or more terminals:** ~~(e.g., LCC, QFN) 20° to 45°~~

5.5.1.3.4 Immersion depth (see figures 2026–13 and 2026–14). Unless otherwise specified, the depth to which terminals are immersed into the solder shall be as follows:

- a. **SMDs (leaded and leadless).** The device shall be immersed in the solder to the minimum depth of .004 inch (0.1 mm).
- b. **4.4.1.1.2 All other devices except those with solder terminals.** The termination terminals shall be immersed in the solder to the seating plane or to within .05 inch (1.27 mm) of the package body of the ~~device under test~~ DUT.
- c. **Devices with solder terminals.** When using the dip soldering procedure on devices with solder terminals, the terminal with wrapping wire shall be immersed in the solder to a minimum depth of .05 inch (1.27 mm) past the wrapping area.

5.5.1.3.5 Number of dipping cycles.

5.5.1.3.5.1 Terminals with non-Gold finishes. Devices with non-Gold finish terminals shall be cycled once in flux and solder, except for the possible duplicate immersion of corner terminals on leadless surface mount devices.

5.5.1.3.5.2 4.4.1.2.1 Solder dipping of gold-plated terminations Terminals with Gold finish. Devices with Gold plated termination terminals shall be cycled twice in flux and solder using either one or two solder pots baths. The first immersion dip is to scavenge the Gold on the termination terminals. The second dip is the solderability test. If two solder baths are used, only the second solder bath is required to be monitored for contaminants in accordance with 4.3.3.

NOTE: It is recommended that a separate solder pot bath be used for the first dip of Gold plated devices terminals. In any case, the user of this test condition should use either two separate pots solder baths, a sufficiently large pot solder bath, or monitor closely the contamination level of a single small pot solder bath to assure that the test is performed as intended solder complies with requirements of 4.3.3.

5.5.2 4.4 Test condition H (hand soldering procedure). The hand soldering procedure can be used on terminals not designed for wave or reflow soldering assembly. These terminations terminals are typically (i.e., hooks, lugs, posts, turrets and other terminal configurations generally having specific wire attachment areas such as hole, notch, or slot. When the device has more than one solder terminal, all solder terminals on the device shall be tested.

5.5.2.1 4.4.1 Application of standard wrapping wire wrap. Prior to application of flux and subsequent soldering, the wire attach area of the termination terminal shall be wrapped 1 to 1.5 turns using the standard wrapping wire specified in 3.4 (see 4.2.4). The standard wrapping wire shall be wrapped such that it will not move during soldering.

5.5.2.2 4.4.2 Application of flux. Flux shall be applied to both the wire standard wrapping wire and the attach area of the termination terminal using any suitable method such as (e.g., brushing or dipping). Excess flux may be blotted or drained from the termination terminal prior to soldering.

5.5.2.3 4.4.3 Solder iron procedure Hand soldering. The termination terminal and standard wrapping wire shall be soldered using the solder specified in 3.2 (see 4.2.4 and 6.h) and the soldering iron specified in 2.5 4.1.2. Heat shall be applied to the connection until the solder has been molten for 5 seconds minimum to 10 seconds maximum. After soldering, the part assembly shall be allowed to air cool. Residue flux shall be removed from the termination by dipping the part in isopropyl alcohol. If necessary, a clean soft cloth, cotton swab, or similar appliance moistened with clean isopropyl alcohol may be used to remove any remaining flux. Wire-wrap terminations.

5.5.2.4 Alternative to hand soldering. As an alternative to hand soldering, the solder terminal with standard wrapping wire may utilize the dip soldering procedure of application methods referenced in 4.3.2 or 4.4.3 5.5.1 to form the assembly of the standard wrapping wire to the solder terminal.

5.5.3 4.4.2 BGA/CGA Test condition S (reflow soldering surface mount simulation). The reflow soldering surface mount simulation test shall procedure simulates surface mount device assembly process and can be performed on ball-and-column-grid-arrays-only SMD packages. The reflow soldering surface mount simulation procedure shall be used only when specified (see 6.a).

5.5.3.1 Preparation of substrate. 4.4.2.1 Ball-grid-arrays. The printing of solder paste onto the substrate can use either a manual or automated procedure as follows:

- a. Manual printing. Place the metallized substrate onto the base fixture. Place the screen print stencil on the substrate. b. Apply the solder paste uniformly across the screen-print stencil to fill the array pattern using the squeegee. c. Slowly remove the stencil off the substrate to avoid smearing the solder paste print.
- b. Automated printing. If automated printing equipment is used, follow the equipment manufacturer's recommended procedure for printing the solder paste to the substrate.

After the solder paste has been printed onto the substrate, ~~c.~~ verify that the printed pattern is equivalent in geometry to the terminal pattern of the device to be tested. ~~d.~~ Lastly, gently press the device down to allow the ~~solder balls~~ device terminals to make contact with the solder paste.

5.5.3.2 Procedure. ~~e.~~ Place the substrate with device in the ~~even~~ applicable reflow soldering apparatus. The reflow soldering profiles shall be ~~per table III~~ in accordance with 4.3.1.1, based on the reflow soldering method used. ~~f.~~ After reflow soldering has completed, remove the assembly from the soldering apparatus and allow ~~the ceramic substrate~~ it to cool to room temperature before handling. ~~g.~~ After the cool down, slowly remove the device from the substrate. The ~~solder balls~~ terminals may adhere slightly to the substrate due to flux residue. ~~h.~~ After cooling, clean the device and substrate in the cleaning solution.

5.6 Terminal cleaning.

5.6.1 Post solder exposure flux removal. All residual flux is to be removed prior to visual inspection of the terminal surface(s). Residual flux ~~shall~~ can be removed from the ~~terminations~~ terminals by dipping the device terminals in ~~isopropyl alcohol or other~~ a suitable solvent cleaning solution. If necessary, a clean soft cloth, cotton swab, or equivalent, moistened with ~~clean isopropyl alcohol or other suitable solvent~~ cleaning solution, may be used to ~~remove all remaining aid~~ in the removal of flux.

5.6.2 Optional pre-solderability testing terminal cleaning. When specified, the customer/~~equipment~~ device manufacturer has the option of cleaning devices to remove carbonate/sulfate deposits caused by exposure of the devices to the ~~steamaging steam preconditioning or cleaning process~~. The customer/~~equipment~~ device manufacturer shall assure that the cleaning process does not adversely affect the physical, mechanical, electrical, or reliability performance of the devices. This ~~pre-solderability testing~~ cleaning process shall be fully documented. ~~For leaded devices only, the cut portions of the lead which expose lead ends shall not be used for examination and evaluation of the solder coverage of the termination.~~

5.7 4.5.1 Examination of ~~terminations~~ terminals.

5.7.1 Inspection conditions. For devices that were subjected to test condition S, the terminals shall be examined as specified. ~~All flux is to be removed prior to visual inspection of the terminal surface.~~ For devices that were ~~dip and look tested~~ subjected to test conditions D or H, the ~~dipped~~ solder covered portion of the ~~terminations~~ terminals shall be examined ~~using a~~ at the following magnification:

- a. For devices with terminal pitch > .020 inch (0.5 mm): 10 - 15x. ~~Dipped portions of~~
- b. For devices with terminal ~~fine-pitch devices~~ (pitch ≤ 0.020 inch (0.5 mm)): ~~shall be examined at~~ 30x.
- c. Verification of failures may be accomplished with higher magnifications up to 60x.

1.1.8 Solder and flux application and minimum depth.

~~1.1.8.1 Dual-in-line packages.~~ The location at which the termination widens to its maximum shoulder dimension or to the package base plane, whichever is the furthest point from the seal.

~~1.1.8.2 Radial lead packages (e.g., flat package, top brazed quads).~~ A location on the lead, no greater than .05 inch (1.27 mm) from the package.

~~1.1.8.3 Axial lead packages (e.g., TO cans, PGA).~~ A location on the lead that is no greater than .05 inch (1.27 mm) from the body of the package, the seating plane, or the standoff, whichever is the furthest from the glass seal.

~~1.1.8.4 Leaded chip carrier (e.g., J bend, gull wing).~~ A location on the leads equal to an extension of the base plane onto the leads, or the point at which the lead widens.

~~1.1.8.5 Leadless chip carriers.~~ A location which is 50 percent of the distance between the top of the castellation and the terminal pad.

~~1.1.8.6 Thread mounted devices with crimped (flattered) hole punched terminals.~~ The flat portion or .050 inches (1.27 mm) below the bottom of the terminal hole toward the device body, which is smaller.

5.7.2 4.5.1 Critical area for dip and look tested devices terminals detailed herein. Examples of critical areas for some devices ~~are discussed~~ packages shall be as detailed below.

- a. **Passive (rectangular) Bottom pad ceramic packages.** The bottom of the termination and side of the termination terminal up to the top, excluding the top side of the package. See figure 2026–4.
- b. **Dual-in line.** For packages where the terminals exit from the side of the device, from the termination terminal tip to .020 inch (0.51 mm) above the seating plane. ~~, except, For packages devices where the leads terminals exit from the bottom of the device, shall be from the termination terminal tip to the seating plane. Unplated (trim) areas are excluded.~~ See figure 2026–5.
- c. **Gull wing.** All surfaces of the termination terminal at or below the top of the foot, excluding the top of the foot. ~~Unplated (trim) areas are excluded.~~ See figure 2026–6.
- d. **J-lead.** The narrow portion of the termination terminal below the transition from the termination terminal shoulder. Only the three visible surfaces are to be included. The termination terminal tip is excluded. See figure 2026–7.
- e. ~~L-lead. The bottom of the termination and one times the lead thickness up the side of the termination. Termination edges are excluded. Leadless chip carrier.~~ The bottom of the termination terminal and $\frac{2}{3}$ of the height of the connecting metallized surface. See figure 2026–8.
- f. **MELFs (UR, US and URS).** The entire end cap surface excluding the inner rim. See figure 2026–9.
- g. **QFN.** The bottom of the termination terminal and exposed pad. See figure 2026–10.
- h. **Round terminals or pins.** The area above the seating plane that is within .050 inch (1.27 mm) of the bottom of the package body or .030 inch (0.76 mm) above seating plane, whichever is the lesser distance. See figure 2026–11. ~~Other devices. .050 inch from the body and extending away from the body to the end of the lead or for a distance of 1 inch, whichever is shorter.~~
- i. **Solder terminals.** The identified surfaces of the terminal where the wire is intended to be wrapped. See figure 2026–12.

5.7.3 Critical area for terminals not illustrated. For terminals on packages not illustrated herein, the following details shall apply:

- a. If the seating plane is not defined, the critical area shall extend from the termination terminal tip to within .040 inch (1.02 mm) of the lead terminal/device interface.
- b. For top-brazed and bottom-brazed flat pack devices, the critical area shall extend from the termination terminal tip to within .070 inch (1.78 mm) of the lead/device terminal-package body interface.

5.7.4 Areas to be excluded. For leaded devices only, the cut or trimmed portions of the terminal which expose the unplated areas or ends shall not be used for examination and evaluation of the solder coverage of the terminal.

5.7.5 4.5 Customer or device manufacturer defined criteria. The customer/equipment device manufacturer of the device may establish a critical zone within the solder coated portion of the termination within the dipped area terminal. The customer/equipment device manufacturer has the option to accept solderability defects outside their established critical area zone. ~~The customer/equipment manufacturer has the option of cleaning devices to remove carbonate/sulfate deposits caused by exposure of the devices to the steamaging or cleaning process. The customer/equipment manufacturer shall assure that the cleaning process does not adversely affect the physical, mechanical, electrical, or reliability performance of the devices. This cleaning process shall be fully documented. For leaded devices only, the cut portions of the lead which expose lead ends shall not be used for examination and evaluation of the solder coverage of the termination.~~

5.8 4.5.2 Criteria for acceptance. ~~The criteria for acceptance solderability shall be as follows:~~

5.8.1 4.5.2.1 For Evaluation of all devices, except those with solder terminals ball and column grid arrays. ~~The criteria for acceptable solderability shall be as follows:~~

- a. The dipped portion of the ~~terminations~~ **terminals** is at least 95 percent covered by a continuous new solder coating.
- b. Pinholes, nonwetting, or dewetting do not exceed 5 percent of the total **solder coated** area.
- c. For leadless ~~terminations terminals and elements having solder attachment terminations~~, there shall be no solder bridging between any ~~termination terminal~~ area and any other metallization not connected to it by design. In the event that the **dip** ~~soldering dipping~~ causes bridging, the test shall not be considered a failure provided that a local application of heat (e.g., gas, soldering iron, or re-dipping) results in solder pullback and no wetting of the dielectric area as indicated by microscopic examination.
- d. For devices with **an** exposed pad (e.g., QFN), the exposed pad surfaces shall exhibit a continuous solder coating free from defects for a minimum of 80 percent of the critical area of those surfaces.
- e. Wetting angle shall be less than or equal to 90 degrees.

5.8.2 4.5.2 Evaluation of devices with solder terminals wire wrap terminations. ~~The criteria for acceptable solderability are shall be as follows:~~

- a. Ninety-five percent of the total length of the fillet, between the standard **wrapping** wire ~~wrap~~ and the ~~termination solder terminal~~, is tangent to the surface of the ~~termination solder terminal~~ being tested and free from pinholes, voids, porosity, nonwetting or dewetting.
- b. A non-uniform flow line where the solder fillet joins with the surface of the ~~termination solder terminal~~ may occur from the method of solder application and is acceptable providing wetting is as specified in 'a' above.

6. 5. Summary. The following details should be specified in the applicable procurement document:
- a. When using parameters other than those specified as default for the applicable test condition:
 - (1). For test condition D.
 - i e. The angle of immersion, if other than specified (see 5.5.1.3.3)
 - ii d. The depth of immersion, if other than specified (see 5.5.1.3.4).
 - (2) For test condition H.
 - i. The type of flux to be used, if other than specified (see 4.2.2).
 - ii. The composition of solder, solder ribbon or solder wire to be used, if applicable (see 4.2.3.3).
 - (3) For test condition S.
 - i 1. The screen-print stencil thickness, if other than specified (see 4.1.3)
 - ii 2. The solder paste composition, if other than specified (see 4.2.2).
 - iii. The substrate material, if other than specified (see 4.2.5).
 - iv. The reflow soldering profile, if other than specified (see 4.3.1.1).
 - b. The terminal finish precondition category letter (see 2.2).
 - c a. The number of terminations-of-each-device terminals to be tested, if other than 22(0) (see 5.2).
 - d b. The number of devices used-for-the to be tested, if other than 3 (see 5.2).
 - e e. Special preparation of the terminations terminals, if applicable other than specified (see 5.3.3).
 - f. Solder composition, flux composition, and soldering temperature, if other than those specified in this document (see 4.2.2, 4.2.4 and 4.3.1).
 - g. Measurements-after-test, where applicable. Examination magnification, if other than specified (see 5.7).
 - h. For ball and column grad arrays: Customer/device manufacturer requirements for special terminal cleaning (see 5.6.2).
 - i. Customer/device manufacturer requirements for critical zone acceptance criteria (see 5.7.5).



FIGURE 2026-1 . Pinholes.

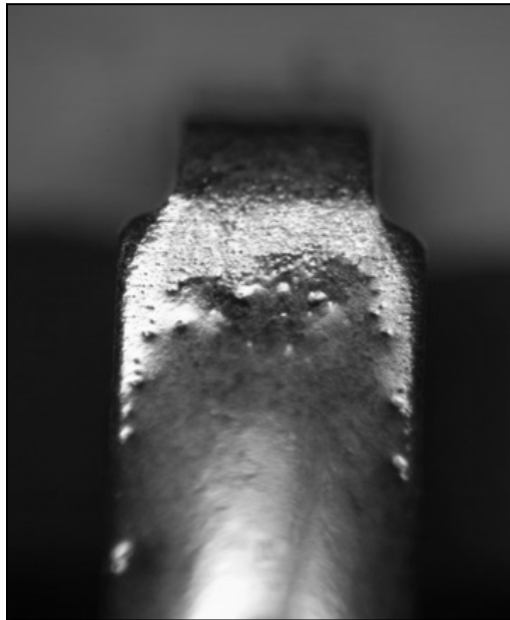
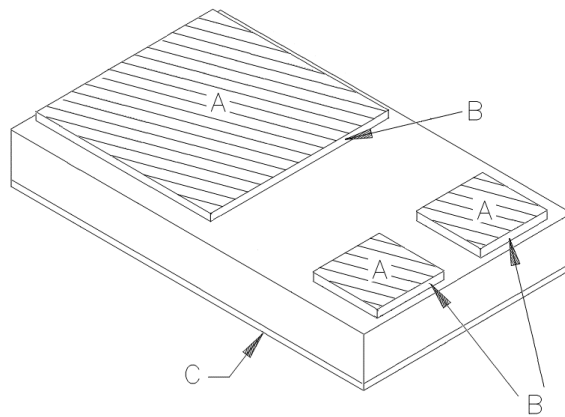


FIGURE 2026-2. Dewetting.



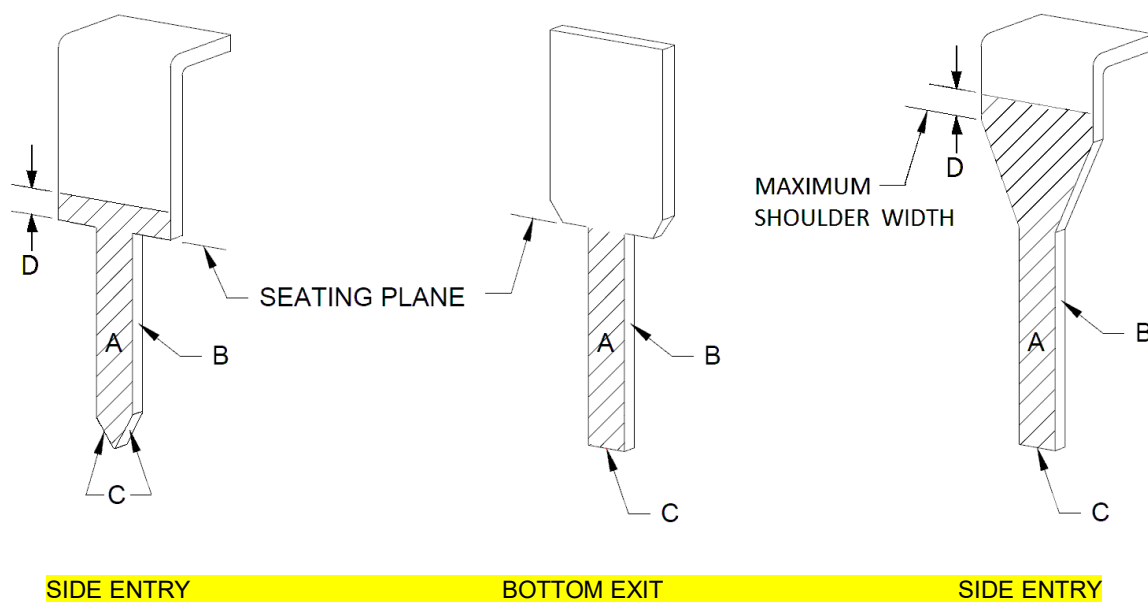
FIGURE 2026-3. Non-wetting.



NOTES:

- a. Critical area = surfaces "A" and "B".
- b. Surface "C" (topside of package) is excluded.

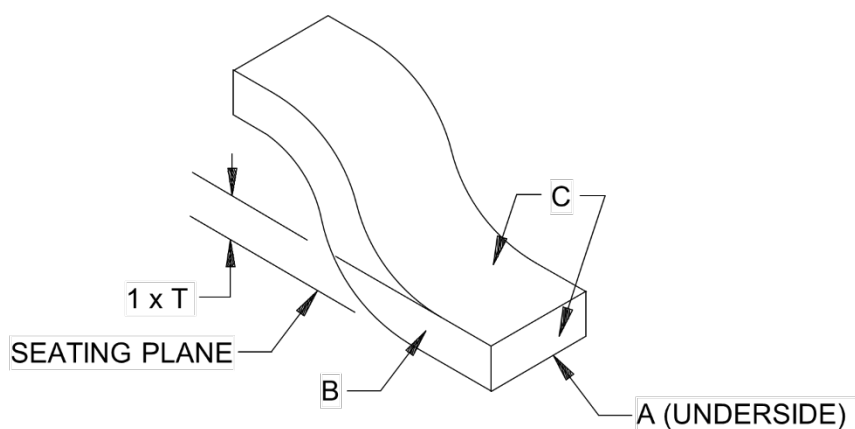
FIGURE 2026-4. Critical area for SMD packages with bottom pad terminals.



NOTES:

- Critical area = surfaces "A" and edges "B".
- Surfaces "C" (bottom and cut sides) are excluded.
- Dimension D = .02 inch (0.51 mm) above seating plane or point of maximum shoulder width.

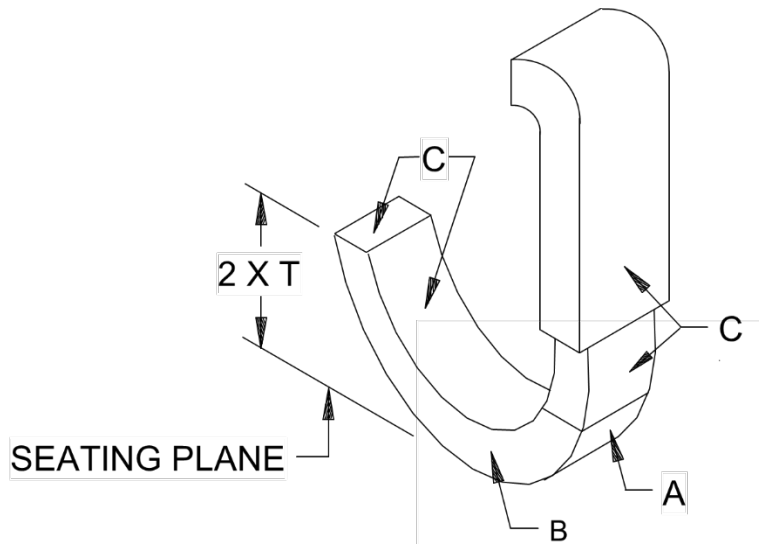
FIGURE 2026-5. Critical area for dual-in line package terminals.



NOTES:

- Critical area = surfaces "A" (up to 1 x lead thickness) and edges "B".
- Surface "C" is excluded.

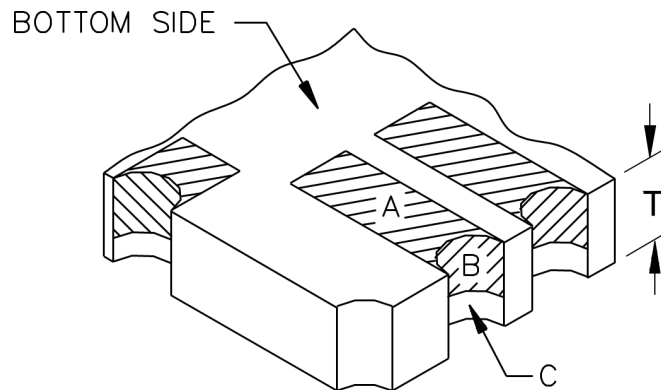
FIGURE 2026-6. Critical area for gull wing terminals.



NOTES:

- Critical area = surfaces "A" and edges "B" within the 2x lead thickness (T) zone.
- Surfaces "C" are excluded.

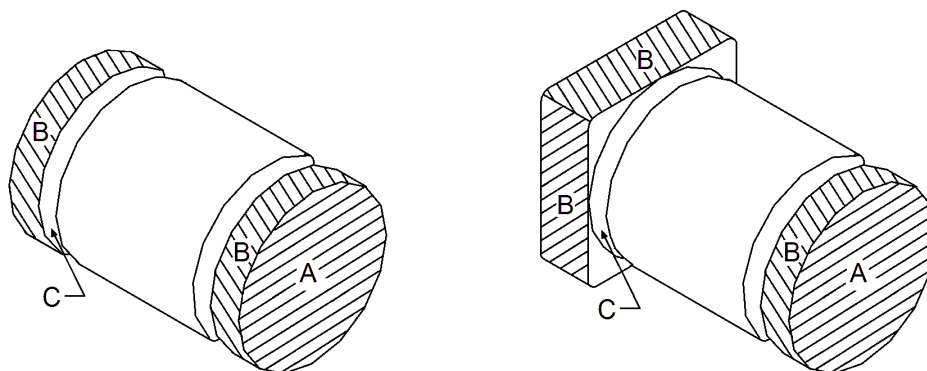
FIGURE 2026–7. Critical area for J-lead terminals.



NOTES:

- Critical area = surfaces "A" and "B". "B" = $\frac{2}{3}$ of "T".
- Surface "C" is excluded.

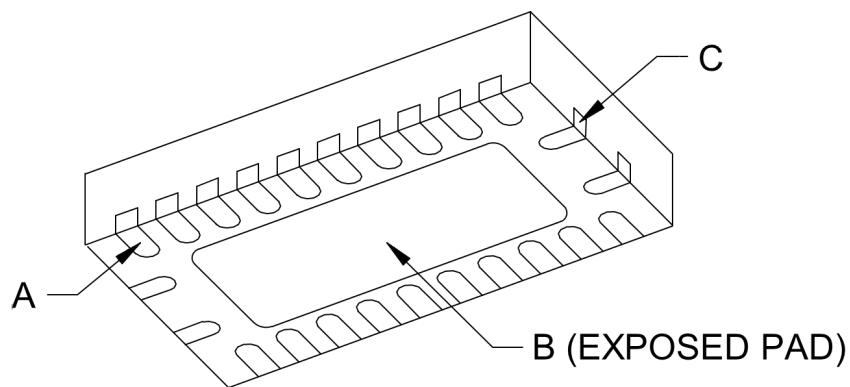
FIGURE 2003–8. Critical area for terminals of leadless chip carrier packages.



NOTES:

- a. Critical area = surfaces "A" and "B".
- b. Surface "C" is excluded.
- c. Package type DO-213 shown.

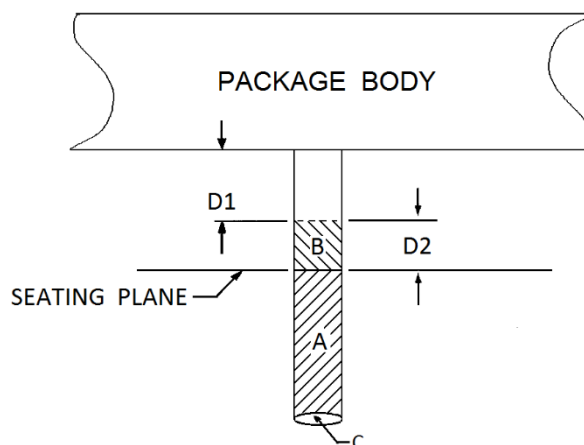
FIGURE 2026–9. Critical area for terminals of MELF (UR, US and URS) packages.



NOTES:

- a. Critical area = surfaces "A" and "B".
- b. Surface "C" is excluded.

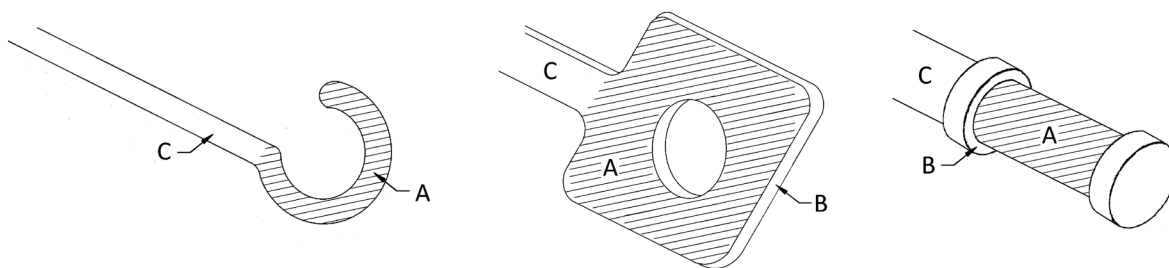
FIGURE 2026–10. Critical area for QFNs.



NOTES:

- Critical area = surfaces "A" and "B". Surface "B" includes the area above the seating plane that is within .050 inch (1.27 mm) of the bottom of the package body (dimension D1) or .030 inch (0.76 mm) above seating plane (dimension D2), whichever is the lesser distance.
- Surface "C" is excluded.

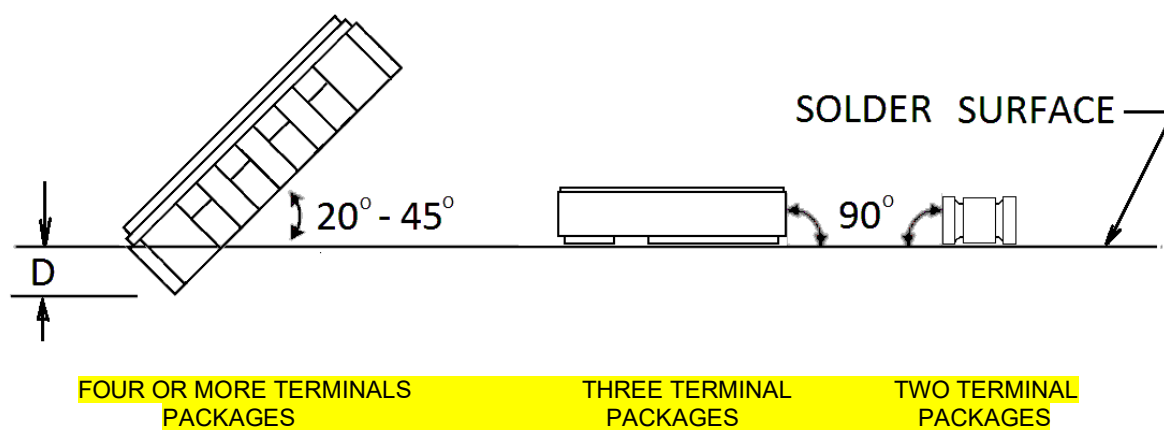
FIGURE 2026–11. Critical area for round-lead terminals.



NOTES:

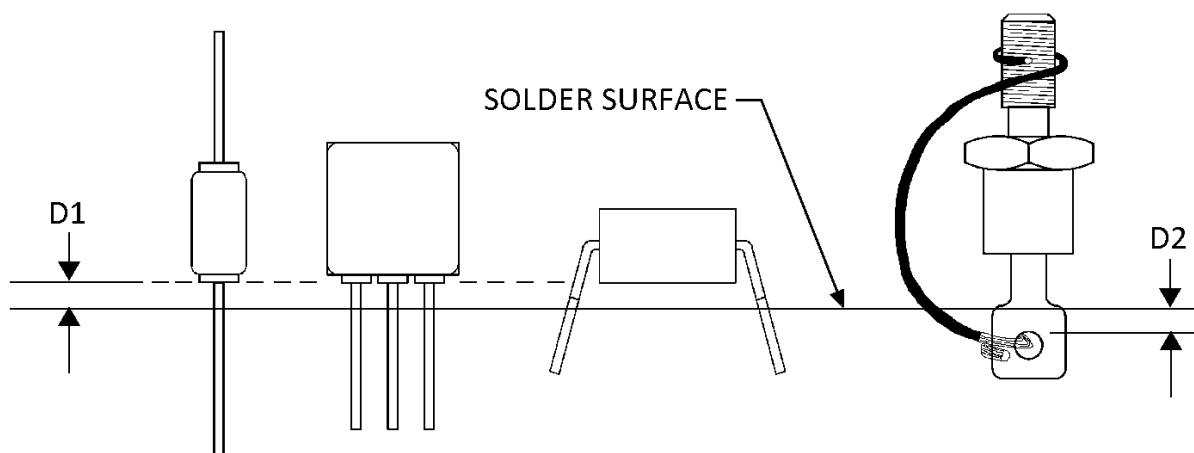
- Critical area = surfaces "A" and "B".
- Surface "C" is excluded.

FIGURE 2026–12. Critical area for solder terminals.



NOTE: Dimension D is .004 inch (0.10 mm).

FIGURE 2026–13. Dipping angle for SMD packages.



NOTES:

- Dimension $D1$ is .05 inch (12.7 mm) above the surface of the molten solder.
- Dimension $D2$ is .05 inch (12.7 mm) below the surface of the molten solder.

FIGURE 2026–14. Dipping depth for through hole mount packages