



AEROSPACE RECOMMENDED PRACTICE

ARP1332

REV. D

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Superseding ARP1332C

Wave Soldering Procedure

RATIONALE

ARP1332D designates a stabilized status for this document due to broader use of industry consensus standard IPC J-STD-001.

STABILIZED NOTICE

ARP1332D has been declared "STABILIZED" by AMS Committee B and will no longer be subjected to periodic reviews for currency. Users are responsible for verifying references and continued suitability of technical requirements. Newer technology may exist. The last technical update of this document occurred in August, 1998. Users of this document should refer any certification issues (e.g. exceptions listed on the certification report) to the cognizant engineering organization for their disposition. CAUTION: In many cases the purchaser is not the cognizant engineering organization (i.e. purchaser may be a sub tier supplier).

AMS Committee B recommends that the following similar specification be used for future procurement. This does not constitute authority to substitute IPC J-STD-001 for the "STABILIZED" specification. Authority for substitution should be granted by, or approved by, the cognizant engineering organization.

IPC J-STD-001, Requirements for Soldered Electrical and Electronic Assemblies.

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1. SCOPE

- 1.1 The purpose of this recommended practice is to provide recommendations concerning the procedure for wave soldering.
- 1.2 The detailed recommendations are based on manufacturing experience and laboratory experiments. The recommendations reflect those design practices and fabricating procedures that have been found to be most effective in producing functional electronic modules for critical communications or control systems. Electronic modules include assemblies, components, and printed circuit (PC) or printed wire (PW) boards.
- 1.3 In the following text, references to printed circuit (PC) boards shall be construed to include printed wire (PW) boards.
- 1.4 Safety-Hazardous Materials

While the materials, methods, applications and processes described or referenced in this procedure may involve the use of hazardous materials, this document does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.5 Warning

The solder used in this document may contain cadmium. The use of cadmium has been restricted and/or banned for use in many countries due to environmental and health concerns. The user should consult with local officials on applicable health and environmental regulations regarding its use.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 257 DC Resistance or Conductance of Insulating Materials

ASTM D 1193 Reagent Water

2.2 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4/D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, <http://assist.daps.dla.mil/quicksearch/>.

MIL-STD-202 Electronic and Electrical Component Parts

2.3 Other Publications

American Society for Metals Handbook

3. GENERAL

- 3.1 A soldered joint is formed when the molten solder "wets" the surfaces of the substrates. Wetting creates a metallurgical bond by formation of intermetallic compounds of tin with the substrate. Penetration into re-entrant cavities and filling of space between surfaces occur by capillary action. Best soldering results are achieved when substrates and leads are wetted quickly and completely by the molten solder. The entire substrate surface should approach perfect wetting conditions.
- 3.2 Surface contamination will impede this metallurgical reaction. Substrate surfaces should be free from oxides and other contaminants to ensure reliable, repeatable soldering conditions required for rapid reaction in the solder wave, where dwell time may be less than 2 seconds. All components and printed circuit board conductor runs should be determined, by lot acceptance test, to possess the optimum surface condition for best solderability. Manipulation of fluxing and soldering often will overcome marginal solderability but can only provide minimum help to components possessing poor solderability.
- 3.3 The solder wave machine uses a vertical wave of molten solder usually produced by an impeller immersed in a sump of molten solder. The impeller pumps the solder between parallel plates so that a crest of solder will exist above the quiescent solder level. Other means of producing a solder wave are acceptable. The electronic module assembly passes over the wave by means of chain-driven conveyor set at a critical angle with respect to the wave crest axis. The depth of board penetration into the solder crest is critical. Depth should be great enough to cause hydrostatic displacement of flux in holes and allow molten solder to flow through the holes by capillarity. Depth should not be so great as to cause solder to break across the component side of the PC board. Advanced soldering lines now incorporate in-line fluxing and pre-solder/post-solder cleaning systems.

4. SOLDER BATH

- 4.1 The optimum composition of tin is 59.5 to 63.5% with the balance of the solder bath consisting of lead and the items in 4.2.2.
- 4.2 Contamination and composition change of the solder bath will occur during operation. The solder should be sampled and analyzed on a periodic basis or when the quality of the soldering decreases. Certain metallic elements are soluble in molten solder and gradually contaminate the solder bath.
- 4.2.1 Extremely heavy deposits of gold plating on electronic components may alloy with molten solder to cause degradation of solidified solder fillets by formation of brittle gold-tin intermetallic compound phases. Surface dewetting will be more prevalent as gold content in the bath increases. Thin (under 120 microinch (3 μm) thickness) coatings of pure gold are extremely solderable and do not cause degradation of solder joints because all the gold is dissolved away during the soldering operation.
- 4.2.2 Some elements such as zinc, aluminum, and cadmium render the solder sluggish and porous. Other elements such as copper and nickel render the solder hard and brittle. Metals such as silver and antimony have little detrimental effect on the solder. Nonetheless, impurities should be maintained at levels as low as possible, preferably below the following limits:

TABLE 1

Element	Content, % by Weight min	Content, % by Weight max
Antimony	0.2	0.5
Copper (4.2.2.1)	--	0.3
Bismuth	--	0.25
Gold (4.2.2.1)	--	0.20
Silver	--	0.10
Arsenic	--	0.03
Iron	--	0.02
Nickel	--	0.01
Phosphorus	--	0.01
Aluminum (4.2.2.1)	--	0.006
Cadmium (4.2.2.1)	--	0.005
Zinc (4.2.2.1)	--	0.005
Sulfur	--	0.001

- 4.2.2.1 Total of copper, gold, aluminum, cadmium, and zinc should not exceed 0.4% by weight.
- 4.2.3 When chemical analysis indicates impurity levels greater than the individual contaminant levels, the entire bath should be discarded or should be restored by addition of virgin solder to maintain low impurity level. A low contamination level is needed to control solder bath fluidity at a given temperature.
- 4.3 The molten solder should be temperature controlled at 230 to 290 °C (450 to 550 °F) for best results. Higher temperatures can cause component degradation and dewetting. Lower temperatures can cause solder bridging, icicling, and poor wetting.
- 4.3.1 The balance between carriage speed and solder temperature is also critical. Because metal component leads and laminate conductor runs or pads possess greater inherent heat capacity than the dielectric board material, the electronic module assembly may be wave soldered at faster speed when the solder temperature is higher with less component or dielectric damage than when wave soldered at slower speed and lower solder temperature.