IPC-J-STD-001 G
Revision Highlights

Requirements for Soldered Electrical and Electronic Assemblies

by
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Understanding the Brackets [A1A2A3] and How to Interpret Them and Use Them
Where, What and Why

**Where** are they defined:

- **Section 1.5 Definition of Requirements:**
- **What:**
  - The words **SHALL** or **SHALL NOT** are used in the text whenever there is a requirement for materials, preparation, process control or acceptance of a solder connection.
Where, What and Why con’t.

Where the word *shall* is used in this Standard, the requirements for each class are in brackets next to the requirement.

N = No requirement has been established for this Class
A = Acceptable
P = Process Indicator
D = Defect

*Examples:*
[A1P2D3] is Acceptable Class 1, Process Indicator Class 2 and Defect Class 3
[N1D2D3] is No requirement has been established Class 1, Defect Classes 2 and 3
[A1A2D3] is Acceptable Classes 1 and 2, Defect Class 3
[D1D2D3] is Defect for all Classes

The word “should” reflects recommendations and is used to reflect general industry practices and procedures for guidance only.
Specification Nomenclature

- 001, soldering specification
- 002, wires and terminal solderability (W&T)
- 003, printed wiring board solderability (PWB)
- 004, flux qualification (FLUX)
- 005, paste qualification (PASTE)
- 006, solder qualification (SOLDER)
Conflict Resolution

Conflict:

- In the event of conflict between the requirements of this Standard and the applicable assembly drawing(s), and documentation the applicable User approved assembly drawing(s) and documentation govern.
Conflict Resolution

• When 001 is cited or required by contract, the requirement of IPC-A-610 do not apply unless separately or specifically required.

• When 610 or other related documents are cited with 001 the order of precedence shall [D1D2D3] be defined in the contract.

• When 610 is used as a companion document to 001 the revisions shall be compatible
Wire Diameter vs Conductor Diameter

- **Conductor**: the diameter if the outside diameter of wire, either stranded or solid, without the insulation.
- **Wire**: the wire diameter is the outside diameter, either stranded or solid, including insulation if present.
Objective Evidence

- **Objective Evidence** Documentation in the form of hard copy, computer data, video, or other media that demonstrate the requirements in the Standard have been met (for example, see Appendix C)
Objective Evidence

Used in section

- 1.10 Personal proficiency
- Section 3 Materials
  - Solder qualification
  - Flux qualification
- Section 4 Gold removal
- Section 7 Process Validation, X-ray
- Section 12 Process Control
Material Compatibility

- 3.1 States – The materials and processes used to assemble/manufacture electronic assemblies shall [D1D2D3] be selected such that their use, in combination, produce products acceptable to this Standard.
Defect Definition Example

3.4 Solder Paste

• Solder paste **shall [D1D2D3]** be in accordance with J-STD-005 or equivalent.

• Solder paste **shall [D1D2D3]** also meet the requirements of 3.2 and 3.3.
4.16.2 Solder Bath

- The period of exposure of any printed board to a solder bath shall [D1D2D3] be limited to a duration that will not degrade the board or parts mounted thereon.
- The solder bath temperature, based on the solder alloy in use, shall [N1D2D3] be set at a predetermined value with a tolerance of ± 5°C [± 9°F].
Lead-Free Conversion

- This happened in 2006 with the European Directive “RoHS”
- Most products today are build with lead-free solder.
- The standard materials melt at higher temperature
- The cost of conversion has been high
J-STD-020 Sn-Pb Profile Development

Adapted from IPC-J-STD-020C
J-STD-020 Lead Free Profile Development

Adapted from IPC-J-STD-020C

<table>
<thead>
<tr>
<th>Pb-Free Assembly</th>
</tr>
</thead>
<tbody>
<tr>
<td>3° C/second max.</td>
</tr>
<tr>
<td>150 °C</td>
</tr>
<tr>
<td>200 °C</td>
</tr>
<tr>
<td>60-180 seconds</td>
</tr>
<tr>
<td>217 °C</td>
</tr>
<tr>
<td>60-150 seconds</td>
</tr>
<tr>
<td>See Table 4.2</td>
</tr>
<tr>
<td>20-40 seconds</td>
</tr>
<tr>
<td>6 °C/second max.</td>
</tr>
<tr>
<td>8 minutes max.</td>
</tr>
</tbody>
</table>

Profile Feature

<table>
<thead>
<tr>
<th>Average Ramp-Up Rate (Tₚₛₘₐₓ to Tₚ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preheat</td>
</tr>
<tr>
<td>Temperature Min (Tₛₘᵢₙ)</td>
</tr>
<tr>
<td>Temperature Max (Tₛₘₐₓ)</td>
</tr>
<tr>
<td>Time (tₛₘᵢₙ to tₛₘₐₓ)</td>
</tr>
<tr>
<td>Time maintained above:</td>
</tr>
<tr>
<td>Temperature (Tₗ)</td>
</tr>
<tr>
<td>Time (tₗ)</td>
</tr>
<tr>
<td>Peak/Classification Temperature (Tₚ)</td>
</tr>
<tr>
<td>Time within 5 °C of actual Peak Temperature (tₚ)</td>
</tr>
<tr>
<td>Ramp-Down Rate</td>
</tr>
<tr>
<td>Time 25 °C to Peak Temperature</td>
</tr>
</tbody>
</table>
Wave Solder Profile Comparison, Lead Free and Leaded

Supplied by SEHO USA
Thermal Profile Guide

Reflow solder heat resistance:
• Reflow peak temperature of 260°C (500°F) for 10 seconds maximum, and reflow zone temperature of 220°C (428°F) for 60 seconds.
• Preheat at 150° - 180° C (302°F – 356°F) for 120 seconds.
• Flow solder heat resistance: 265°C (509°F) for 10 seconds.

Adapted from Rohm, Heat Resistance Assured
Lead Free Reflow Profile Example

Adapted from Optimizing Lead-free Reflow Processes by Peter Biocca

Recommended Reflow Curve:

- Peak temp: 235 - 255°C
- Reflow zone time above 217°C (90 sec max)
- Pre-heating zone <2.5 C/sec

Recommended Lead-Free Thermal Profile

- Pre-Heat 190°C Max 120 sec Max
- Keep 220°C Max 60 sec Max

N.B. Preheat is considered especially important for Pb-free soldering in order to minimise thermal shock risks.

Recommended Wave Soldering condition:
260 degC, 10 seconds, 1 cycle
Tin/Lead, (Sn/Pb) Phase Diagram
Tin/Silver/Copper, Sn/Ag/Cu

Reflow Temperature 219 - 217
Tin/Bismuth/Silver, Sn/Bi/Ag

Reflow Temp 137.1 C
Tin/Silver, Sn/Ag

Reflow Temperature 220.3°C

Differences between Tin/Lead and Lead-Free

Figure 5-18  SnPb Solder

Figure 5-19  SnAgCu Solder
Table 7-4

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical solder fill for components with less than 14 leads not connected to an internal thermal plane, Notes 2 and 3 (see 7.3.5.1).</td>
<td>Not Specified</td>
<td>75%</td>
<td>75%</td>
</tr>
<tr>
<td>Vertical solder fill for each lead that is connected to a thermal plane, on components with less than 14 leads, Notes 2, 3 and 4 (see 7.3.5.1).</td>
<td>50% or 1.2 mm [0.05 in], whichever is less</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vertical solder fill for components with 14 leads or more, Notes 2 and 3 (see 7.3.5.1).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circumferential wetting of lead and barrel on solder destination side (see 7.3.5.2).</td>
<td>Not Specified</td>
<td>180°</td>
<td>270°</td>
</tr>
<tr>
<td>Percentage of land area covered with wetted solder on solder destination side (see 7.3.5.3).</td>
<td>0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Circumferential wetting of lead and barrel on solder source side (see 7.3.5.4).</td>
<td>270°</td>
<td></td>
<td>330°</td>
</tr>
<tr>
<td>Percentage of land area covered with wetted solder on solder source side (see 7.3.5.5).</td>
<td>75%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note 1. Wetted solder refers to solder applied by the solder process. For intrusive soldering there may not be an external fillet between the lead and the land.

Note 2. The unfilled height includes both source and destination side depressions.

Note 3. Less than 100% solder fill may not be acceptable in some applications, e.g., thermal shock, electrical performance. The User is responsible for identifying these situations to the Manufacturer.

Note 4. For Class 2 vertical solder fill, 50% or 1.2 mm [0.05 in], whichever is less, is allowed provided there is 360° wetting to the PTH lead and barrel wall on the solder source side.
Wire to Terminal Definition

Acceptable - Class 1, 2
- Depression of solder between the terminal and the wrap of the wire is less than or equal to 50% of the wire/lead radius (R), see Figures 6-70 and 6-72-2.

Acceptable - Class 3
- Depression of solder between the terminal and the wrap of the wire is less than or equal to 25% of the wire/lead radius (R), see Figures 6-70 and 6-72-2.
6.1.3 Lead Trimming

- Leads may be trimmed after soldering provided the cutters do not damage the component or solder connection due to physical shock.
- Tempered leads shall not [N1D2D3] be trimmed unless specified on the drawing(s) and documentation.
Lead Trimming

When Leads are cut after soldering:

- The solder terminations shall \([N1D2D3]\) either be reflowed or visually inspected at 10X to ensure that the original solder connection has not been damaged (e.g., Fractured) or deformed.
- Lead trimming after soldering that cuts into solder fillets shall \([N1N2D3]\) be reflowed, see figure 6-3.

![Figure 6-3 Lead Trimming](image)
Lead Trimming

- If the solder connection is reflowed this is considered part of the soldering process and not rework.
- This requirement does not apply to components that are designed such that a portion of the lead is intended to be removed after soldering (e.g., Break-away tie bars).
What Does “The Lead is Discernible” Really Mean?
discernible
[dih-sur-nuh-buh l, -zur-]

adjective
1. capable of being discerned; distinguishable.

Also, discernable

http://dictionary.reference.com/browse/Discernible
Discernible, the Definition

discernible

• *Adjective*

• **1.** Capable of being seen: perceivable, perceptible, seeable, viewable, visible, visual.

• **2.** Capable of being noticed or apprehended mentally:
  – appreciable, detectable, distinguishable, noticeable, observable, palpable, perceivable, perceptible, ponderable, sensible.

http://www.thefreedictionary.com/discernible
7.5.17 Flattened Post Connections

- Criteria have not been established for Class 3 for this termination style. Process development and control is essential for continued success of assembly methods.

- Connections formed to components with flattened post connections (Figure 7-18) shall meet the dimensional and solder fillet requirements of Table 7-20.
N3, what does it mean?

<table>
<thead>
<tr>
<th>Feature</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Termination Overhang, Square Solder Land</td>
<td>75% Termination Width (W), Notes 1, 2</td>
<td>50% Termination Width (W), Notes 1, 2</td>
<td>Criteria not established</td>
</tr>
<tr>
<td>Maximum Termination Overhang, Round Solder Land</td>
<td>50% Termination Width (W), Notes 1, 2</td>
<td>25% Termination Width (W), Notes 1, 2</td>
<td></td>
</tr>
<tr>
<td>Maximum Fillet Height</td>
<td>Note 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimum Fillet Height</td>
<td>Note 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note 1:** Does not violate minimum electrical clearance.

**Note 2:** Lead diameter is less than diameter or side length of the solder land.

**Note 3:** Wetting is evident.

**Note 4:** Solder does not touch component body.
Cleaning, Section 8

• This section is being rewritten as the old section has been inadequate to properly defined the cleanliness of the boards.

• Information can be found in a IPC-WP-019A, titled, “An Overview on Global Change in Ionic Cleanliness Requirements”
Thank You

any Questions?