

IPC/JEDEC J-STD-609A Marking and Labeling of Components, PCBs and PCBAs to Identify Lead (Pb), Lead-Free (Pb-Free) and Other Attributes

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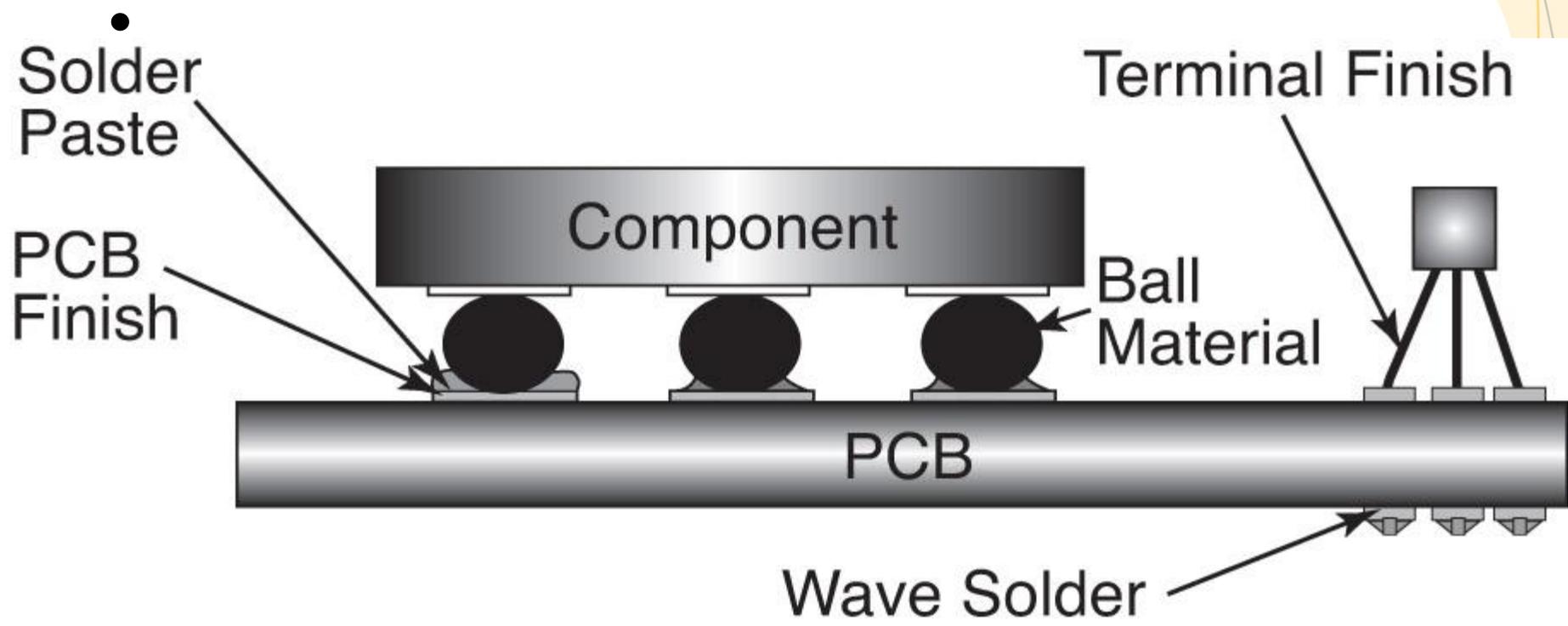
Purpose of IPC/JEDEC J-STD-609 standard

- This standard provides a marking and labeling system that aids in assembly, rework, repair and recycling and provides for the identification of:
 - Assemblies assembled with Pb-containing or Pb-free solder
 - Components with Pb-containing or Pb-free 2nd level interconnect terminal finishes and materials
 - Maximum component temperature not to be exceeded during assembly or rework processing
 - Base materials used in the PCB construction, including those PCBs that use halogen-free resin
 - Surface finish of PCBs
 - Conformal coating on PCBAs

IPC/JEDEC J-STD-609 Standard Scope

- Applies to components and assemblies that contain Pb-free and Pb-containing solders and finishes.
- Describes the marking of components and labeling of their shipping containers to identify their 2nd level terminal finish or material.
- Applies to boards/assemblies, to identify the type of Pb-free or Pb-containing solder used.
- Documents a method for identifying board surface finishes and Printed Circuit Board (PCB) resin systems.
- Applies to PCB base materials and for marking the type of conformal coating utilized on Printed Circuit Board Assemblies (PCBAs).

Examples of materials that comprise the 2nd Level Interconnect



2nd Level Interconnect Categories

- The following categories describe the 2nd level interconnect terminal finish or solder ball material of components or the solder paste/solder used in board assembly.

Pb-containing

e0 – contains intentionally added Pb

- For Pb-containing 2nd level interconnect terminal finishes and materials, the Pb content for e0 is typically > or = to 3 wt%.
- For Pb-containing solder, solder paste, and wave solder alloy, the Pb content is typically > 3 wt% and usually is 37 wt%.

Pb-free 2nd Level Interconnect Categories

- Items previously labeled or marked as e1 or e2 may now be described by the definitions of categories e1, e2 or e8 depending on silver content.
- **e1** - tin-silver-copper (SnAgCu) with silver content greater than 1.5% and no other intentionally added elements e.g. Sn3Ag0.5Cu
- **e2** - tin (Sn) alloys with no bismuth (Bi) nor zinc (Zn), excluding tin-silver-copper (SnAgCu) alloys in e1 and e8 e.g. Sn3.5Ag
- **e8** - tin-silver-copper (SnAgCu) with silver content less than or equal to 1.5%, with or without intentionally added alloying elements. This category does not include any alloys described by e1 and e2 or containing bismuth or zinc in any quantity. e.g. Sn1Ag0.5Cu
- Category e8 was added in this standard amendment and **shall** be applied to the labeling and marking of all new items.

Pb-free 2nd Level Interconnect Categories

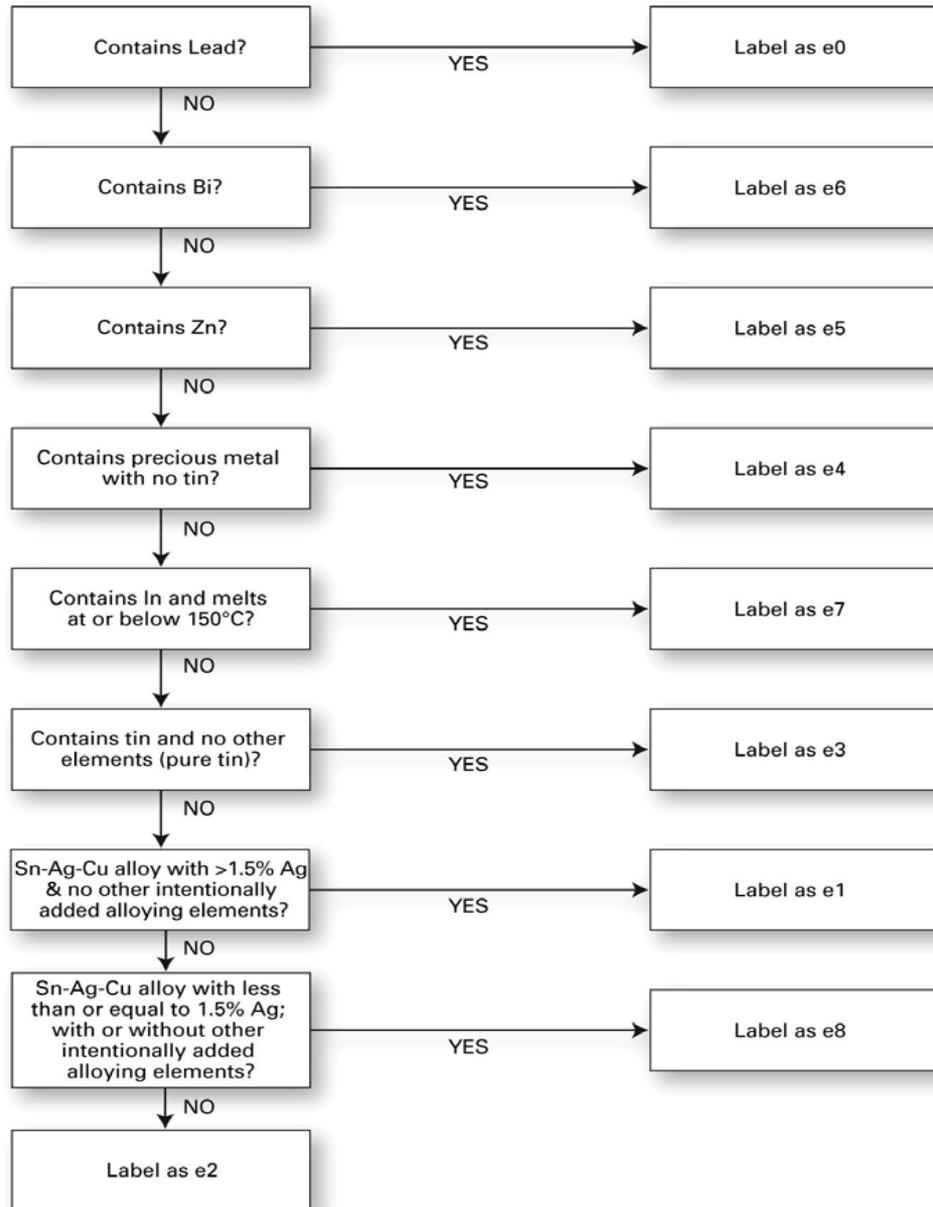
- **e3** - tin (Sn)
- **e4** - precious metal (e.g., silver (Ag), gold (Au), nickel-palladium (NiPd), nickel-palladium-gold (NiPdAu) (no tin (Sn))
- **e5** - tin-zinc (SnZn), tin-zinc-other (SnZnX) (all other alloys containing tin (Sn) and zinc (Zn) and not containing bismuth (Bi))
- **e6** - contains bismuth (Bi)
- **e7** - low temperature solder (≤ 150 °C) containing indium (In) [no bismuth (Bi)]
- **e9** – unassigned symbol.

Appendix A and Appendix B indicate examples of Pb-free e-code applications and e-code selection.

Appendix A: Example Alloys and Associated Material Codes

Alloy Composition	e-code
Sn-2.0Ag-0.5Cu (SAC205)	e1
Sn-3.0Ag-0.5Cu (SAC305)	e1
Sn-4.0Ag-0.5Cu (SAC405)	e1
Sn-3.8Ag-0.9Cu (SAC387)	e1
Sn-3.5Ag	e2
Sn-3.7Ag	e2
Sn-4.0Ag	e2
Sn2Ag0.5Cu+0.05Ni	e2
SAC 305+0.05Ni+0.5In	e2
Sn-2.5Ag-0.5Cu+0.5Co	e2
Sn-3.5Ag + 0.05-0.25La	e2
Sn-0.7Cu	e2
Sn-3.0Ag-0.5Cu + 0.019Ce	e2
Sn-2.5Ag-0.8Cu-0.5Sb	e2
Sn-0.7Cu-0.05Ni	e2
Sn-0.7Cu-0.05Ni + Ge (SN100C)	e2
Sn-0.3Ag-0.7Cu+Bi (SACX)	e6
Sn-0.3Ag-0.7Cu+Bi+Ni+Cr (SACX)	e6
Sn-1.0Ag-0.5Cu + 0.02Ti	e8
Sn-1.0Ag-0.7Cu+0.1Ge	e8
Sn-1.2Ag-0.5Cu+0.5Ni (LF35)	e8
Sn-1.0Ag-0.5Cu (SAC105)	e8
Sn-1.0Ag-0.1Cu+0.02Ni+0.05In	e8

Appendix B: Material Code Flow Chart



Material Category Symbol

- This symbol is used to identify a terminal finish or material category.

e2

e2

e2

(e2)

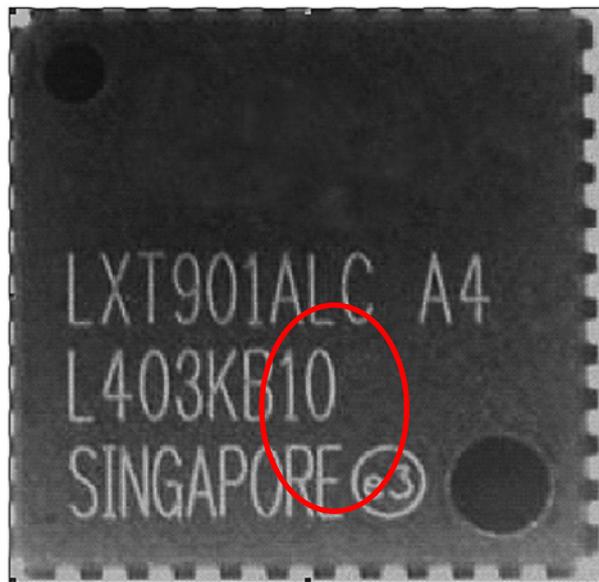
Example of mark indicating material category 2 and the optional circle, ellipse, underline or parentheses

Method of Marking

- The methods for marking of the board (e.g., screen print, etch, laser, label, modification of existing bar code, etc.) are optional but **shall** be legible to corrected, unmagnified vision.

Component Marking

- If space permits, the individual component **shall** be marked on its topside with the Material Category designation enclosed within a circle, ellipse, underlined, or in parentheses.



Example of Component Marking

- If the 2nd level interconnect termination finish or material is removed and replaced on a component, the original 'e' code marking on that physical component **shall** be obliterated and the component **shall** be remarked with the applicable 'e' code.

Lowest Level Shipping Container Labeling

- The Material Category and the maximum component body temperature **shall** be indicated on the lowest level shipping container utilizing the 2nd level interconnect component label

2nd Level Interconnect Component Label

- This label, if used, is placed/printed on the lowest level shipping container and any “ESD”, ”Dry pack” or other bag/box, within the lowest level shipping container.

2nd Level Interconnect

1. Category e0
If blank, see adjacent bar code label
2. Maximum component temp °C
If blank, see adjacent label

Example of 2nd Level Interconnect Component Label indicating
a Pb-containing material

2nd Level Interconnect Component Label

2nd Level Interconnect

1. Category e2
If blank, see adjacent bar code label
2. Maximum component temp 260 °C
If blank, see adjacent label

Example of 2nd Level Interconnect Component Label
indicating a Pb-free e2 material with a maximum component
temp. of 260°C

PCB Base Material Categories

- The PCB base materials may be identified by using the classification system found in IPC-4101, where a Specification Sheet (“slash-sheet”) number identifies a specific material grade.
- Some common base materials used on PCBs are:
 - / 92: Phosphorous flame retardant; Tg 110 to 150° C
 - / 95: Aluminum Hydroxide flame retardant; Tg 150 to 200° C
 - / 99: Bromine flame retardant; contains inorganic fillers; Tg 150° C min.
 - / 126: Bromine flame retardant; contains inorganic fillers; Tg 170° C min.
- For PCBs made with more than one grade of materials, mark or label slash-sheet of the material with the lowest temperature rating.

Halogen-free Base Material

- If the base materials used in making the bare printed board are halogen-free, the label/marketing "HF" shall be noted on the bare printed circuit board.
- This marking applies only to the PCB base material and is not to be interpreted as an indication of a halogen-free (HF) assembly.

PCB Surface Finish Categories

The following categories describe the predominant surface finish on the bare board (prior to assembly).

Pb-containing

- b0 – contains Pb, traditional tin-lead (SnPb), hot air solder level (HASL) or solder reflow

Pb-free

- b1- Pb-free HASL [tin (Sn) alloys with no bismuth (Bi) nor zinc (Zn)]
- B2-immersion silver (Ag)
- B3-tin (Sn) (electrolytic or immersion)
- B4-gold (Au) (immersion or electrolytic), electroless nickel immersion gold (ENIG), nickel gold (NiAu)
- B5-screened carbon (carbon ink)
- B6-organic solderability preservative (OSP)

b7, b8 and b9 - unassigned

Conformal Coating Categories

The following categories (per IPC-CC-830) shall describe the conformal coating, if used.

- ER – Epoxy Resin
- UR – Urethane Resin
- AR – Acrylic Resin
- SR – Silicone Resin
- XY – Paraxylylene

PCB Marking

- Any printed circuit board surface finish with Pb >0.1% **shall** be marked with the Pb category b0.
- Space permitting, the printed circuit board finish may be marked with the material categories.
- In addition, the base PCB material may also be marked with the material categories.
- Also if space permits, the IPC base material specification number may be added before the slash sheet number if the specification is other than IPC 4101.

PCB Shipping Container Labeling

- The label on the lowest level PCB shipping container **shall** contain the information that is applicable to the bare board marking.

Assembly Marking

- The solder paste/solder used shall be identified on an assembly.
- If used, the conformal coating used **shall** be identified on an assembly.
- If the PCB was previously marked with the applicable category for solders and/or conformal coating and the sequence written does not match the materials used during assembly, the PCBA **shall** be remarked.

Solder Category Marking Sequence

- If two or more solder alloy categories are used the category of the solders used **shall** be shown in the following sequence: Reflow, wave and other.

Assembly Shipping Container Labeling

- The label on the lowest assembly level shipping container **shall** contain the information applicable to the assembly marking.

Board/ Assembly Marking Sequence

The sequence of marking, as required, **shall** be as follows:

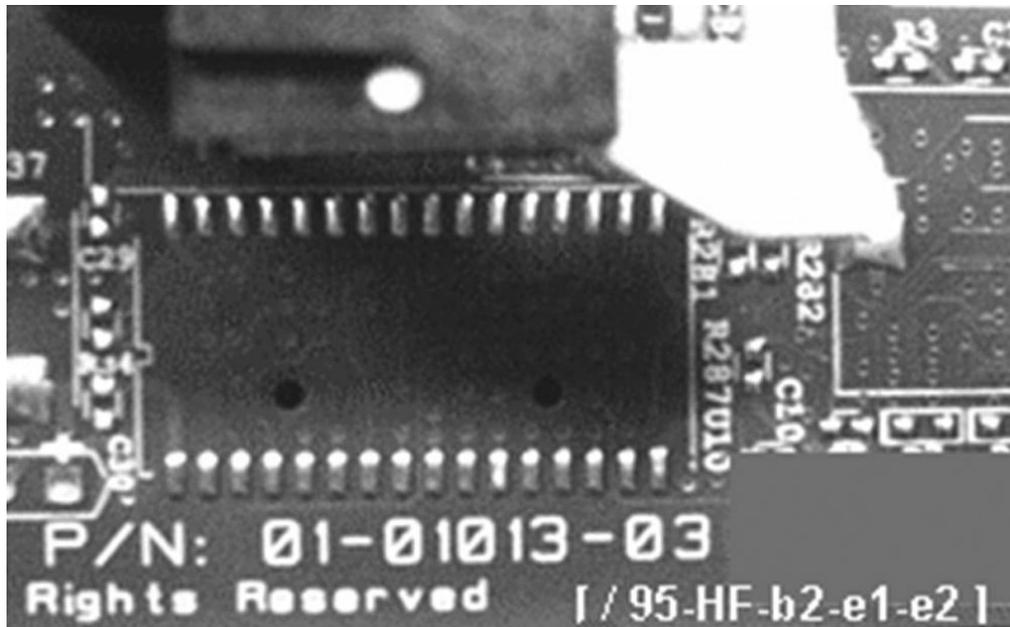
- base material slash sheet number
- halogen-free base material
- PCB surface finish
- reflow, wave and other solders
- conformal coating (if applicable)

Board/ Assembly Marking Examples:

- Multifunctional epoxy, halogen-free FR-4 laminate PCB with immersion silver (Ag) surface finish; assembly used tin-silver-copper (SnAgCu) solder for reflow with silver content greater than 1.5% and no other intentionally added elements and a tin (Sn) alloy with no bismuth (Bi) or zinc (Zn) excluding SnAgCu alloys mentioned in e1 and e8 for wave attachment; no conformal coating.
 - /95 HF b2 e1 e2 or /95-HF-b2-e1-e2 or /95/HF/b2/e1/e2
- Halogen containing epoxy FR-4 laminate PCB with Pb-containing surface finish; assembled with Pb-containing solder; epoxy conformal coating.
 - /99 b0 e0 ER or /99-b0-e0-ER or /99/b0/e0/ER

Board/Assembly Marking Location

- The preferred location for marking the material categories on the board/assembly is on PCB layer 1 (topside) at the lower right-hand segment or next to the part/serial number on the board, or next to the company logo.
- The marking sequence **shall** be clearly identifiable and separate from other board markings.



Example of Board/Assembly Markings

Re-marking Changes in PCBA Materials

- If changes, rework, or repair to assemblies are made with a material finish category code different than marked, then the marking sequence **shall** be appended with the material code for the rework or repair solder and/or conformal coating used.

Marking and Labeling of Pb Components

- Suppliers whose customers require labeling and marking to indicate Pb content in 2nd level interconnect finishes and materials **shall** utilize the Material Category code (e0).

Pb Marking and Labeling of PCBs

- Suppliers whose customers require labeling and marking of PCBs to indicate Pb content in PCB surface finishes **shall** utilize the Material Category code(s) as established (b0).
- Solders to be used in assembly may be marked with category code (e0) on the PCB if specified by the purchaser.

Pb Marking and Labeling of PCB Assemblies

- Suppliers whose customers require labeling and marking of the PCB assembly to indicate Pb content in assembly solders **shall** utilize the Material Category code e0.

Table 9 Marking and Labeling Summary

Item	Preferred Location	Marking or Labeling Content Requirements	
		Required	Comments
Component Marking (Clause 6)	Component body, topside	- Material category for component terminal finish or material (5.3)	Space permitting
Component Container Label (Clause 6)	Lowest level shipping container AND any "ESD", "Dry Pack" or other bag or box within the shipping container	- Material category for component terminal finish or material (5.3) - Maximum component body temperature (3.13)	
PCB Marking (7.1)	Topside, lower right-hand corner; or next to part/serial number or company logo	- PCB surface finish containing lead (Pb) (5.2) - Halogen-free mark [HF] if applicable (5.1.1) - Solders and conformal coating to be used by assembler if specified by purchaser	Sequence: Space permitting IPC spec. number, slash-sheet no, [HF], PCB finish, solders, [conformal coating] (7.9)
PCB Container Label (7.1.1)	Lowest level container holding PCBs	Mark or label with the information applicable to the PCB	
PCBA Marking (7.2)	Topside, lower right-hand corner; or next to part/serial number, or company logo	- Mark with material category for assembly solder type(s) used (5.3) in the order of application (7.3) - Conformal Coating, if any (5.4)	Pb-free symbol marking or label cannot be used on PCBA if any component is not Pb-free
PCBA Container Label (7.2.1)	Lowest level container holding PCBAs	Mark or label with the information applicable to the PCBA	

Conclusions

- The standard covers marking and labelling of both tin-lead and lead-free components, boards and solders used in 2nd level assembly.
- Other areas covered include board base material type and surface finish, conformal coating and component temperature rating.
- A major update of IPC JEDEC J-STD-609A has been the addition of the **e8 material code** which helps to describe and clarify materials codes for e1 and e2 together with e8 in terms of silver content.
 - **e1** – SnAgCu alloys with silver content greater than 1.5% and no other intentionally added elements e.g. Sn3Ag0.5Cu
 - **e2** - tin (Sn) alloys with no bismuth (Bi) nor zinc (Zn), excluding tin-silver-copper (SnAgCu) alloys described in e1 and e8 e.g. Sn3.5Ag
 - **e8** - SnAgCu alloys with silver content less than or equal to 1.5%, with or without intentionally added alloying elements with no bismuth(Bi) or zinc (Zn) e.g. Sn1Ag0.5Cu

Next Steps

- Submit IPC JEDEC J-STD-609A standard to IEC committee to help to promote a global labelling standard.

Acknowledgements

- We would like to thank the various persons on the IPC and JEDEC labelling sub-committee for input into the standard.