

PBA Design-for-Manufacturing Guideline

EDM-D-002 Electronic Component Specification for Printed Board Assembly

V1.3
September 2017

Contact

Geert Willems

Phone: +32 16 288962

Mobile: +32 498 919464

Geert.Willems@imec.be

IMEC

Kapeldreef 75

B3001 Heverlee

Verantwoordelijke uitgevers

Luc Van den Hove - IMEC

Copyright © imec 2017 All rights reserved.

Only an authorized person is hereby permitted to view and use this document subject to the following conditions:

1. This document may be used for informational purposes only.
2. Any copy of this document or portion thereof must include the copyright notice.
3. This information is provided "AS IS" and without warranty of any kind, express, implied, statutory, or otherwise.
4. Imec shall not be liable for any actual, direct, indirect, incidental or consequential damages arising out of the use, performance or application of this document.

Permission is not granted for resale or commercial distribution or use of the document, in whole or in part, or by itself or incorporated in another work.

The Design-for-eXcellence Guidelines principles

The PBA Design-for-eXcellence (DfX) Guidelines are designed to provide all electronic supply chain actors involved in the design, qualification, industrialization and production of Printed Board Assemblies practical guidelines to master the multi-disciplinary hardware aspects of electronic module realization and operation in a cost-effective way. The PBA DfX Guidelines are not electrical design guidelines. The PBA DfX guidelines provide the electrical designer the boundary conditions of industrial electronic manufacturing technology and operational reliability. It is intended to support the development of cost-effective, reliable PBA with a short time-to-market requiring a minimum number of design iterations.

Some of the characteristics of the PBA DfX Guidelines are:

- The PBA DfX Guidelines are oriented towards the overall optimization of the physical design of the final PBA based product.
- The guidelines refer to the relevant industry standards that are predominantly used in the international electronics industry such as those published by organizations as IPC and JEDEC. The guidelines do not replace industrial standards but define or recommend what options in the standards to use and will fill-in gaps if necessary. They provide the basis on which a company/product/product-line or application specific approach for design, industrialization and/or realization can be defined.
- Scientific argumentation and physical models form the basis of a large part of the guidelines and of the associated tools. This allows the use of the guidelines beyond the boundary of the users' experience domain. Therefore, it provides a powerful product and process innovation aid.
- The PBA DfX Guidelines will not specify, recommend or exclude specific brands of materials, components, suppliers or products. They will put forward minimal requirements on quality, physical and chemical properties and testing. They define and provide the DfManufacturing window for PBA realization.
- The PBA DfX Guidelines are based on verifiable physical models, standards and empirical data.

PBA DfX Guidelines Scope

- The PBA DfX guidelines cover lead-free SnAgCu and SnPb solder based assembly.
- The PBA DfX guidelines include: Design-for-Manufacturing, Design-for-Assembly, Design-for-Test, Design-for-Reliability, Design-for-RoHS, etc.

Acknowledgement

This document was realized in collaboration with the industrial and academic partners of imec's Center of Electronics Design & Manufacturing and Sirris.

Funding organizations

IWT is acknowledged for funding the VIS projects - especially the Collective Research project CO-PBA-DfX and the VIS-traject PROSPERITA - that have provided the scientific background for the PBA DfX Guidelines and gained the necessary industry support.

imec contributors

Geert Willems, Ph.D.

Contributing cEDM partners

ASML, Veldhoven, The Netherlands
Barco, Kortrijk, Belgium
Connect Group, Poperinge, Belgium
Eurocircuits, Mechelen, Belgium
PsiControl, Ieper, Belgium

NEVAT/EMS - Technologiegroep, The Netherlands

Table of Contents

The Design-for-eXcellence Guidelines principles	2
PBA DfX Guidelines Scope	2
Acknowledgement	3
1. Applicable Documents	5
2. Applicability of the PBA DfX Guideline EDM-D-002.....	6
3. RoHS and ELV Compliancy	7
4. General Quality Specification	8
5. SMD SnPb soldering compatibility	9
5.1. SMD SnPb metallurgical compatibility	9
5.2. SMD SnPb reflow soldering compatibility	9
5.3. SMD SnPb wave soldering compatibility.....	10
6. SMD Lead-Free soldering compatibility.....	11
6.1. SMD Sn(Ag)Cu Metallurgical compatibility	11
6.2. SMD Lead-Free Reflow soldering compatibility	11
6.3. SMD Lead-Free Wave soldering compatibility	12
7. Through-hole component solderability	13
8. Press-fit components	13
9. Manufacturability aspects of package choices	14
9.1. SMD versus through-hole versus press-fit components.....	14
9.2. SMD minimal pitch	14
9.3. SMD minimal size.....	14
9.4. Maximum SMD component size	15
9.5. High density, standard and large components	16
9.6. Leadless components.....	17
9.7. Component replacement	17
9.8. Adjustable components	17
10. Reliability aspects of SMD package choices	18
10.1. SMD Solder joint reliability	18
10.2. Surface Insulation Resistance	19
10.3. Tin whiskers	19
10.4. Gold embrittlement	20
11. Component marking, packaging and labeling.....	20
Revisions	21

1. Applicable Documents

This PBA DfX Guideline refers as part of the guideline to the most recent versions of the following documents and standards including their amendments.

EDM-D-003	PBA Assembly Material Specification
GR-78-CORE	Generic Requirements for the Physical Design and Manufacture of Telecommunications Products and Equipment
IPC-6012	Qualification and Performance Specification for Rigid Printed Boards
IPC-A-610	Acceptability of Electronic Assemblies
IPC-CC-830	Qualification and Performance of Electrical Insulating Compound for Printed Board Assemblies
IPC-CH-65	Guidelines for Cleaning of Printed Boards and Assemblies
IPC-CM-770	Guidelines for Printed Board Component Mounting
IPC-D-279	Design Guidelines for Reliable Surface Mount Technology Printed Board Assemblies
IPC-HDBK-001	Handbook and Guide to Supplement J-STD-001
IPC-HDBK-850	Guidelines for Design, Selection and Application of Potting Materials and Encapsulation Processes Used for Electronics Printed Circuit Board Assembly.
IPC-TM-650	IPC Test Methods
JEP-95	JEDEC registered and standard outlines for solid state and related products
JEP-155	Recommended ESD Target Levels for HBM/MM Qualification
JESD22-A121A	Test Method for Measuring Whisker Growth on Tin and Tin Alloy Surface Finishes
JESD201A	Environmental Acceptance Requirements for Tin Whisker Susceptibility of Tin and Tin Alloy Surface Finishes
JP-002	Current Tin Whiskers Theory and Mitigation Practices Guideline
JS-001	ESDA/JEDEC Joint Standard for Electrostatic Discharge Sensitivity Testing - Human Body Model (HBM) - Component Level
J-STD-001	Requirements for Soldering and Electronic Assemblies
J-STD-002	Solderability tests for Component leads, Terminations, lugs, terminals and Wires.
J-STD-020	Moisture/Reflow Sensitivity Classification for Nonhermetic Solid State Surface Mount Devices
J-STD-030	Guideline for Selection and Application of Underfill Material for Flip Chip and Other Micropackages
J-STD-033	Handling, Packing, Shipping and Use of Moisture/Reflow Sensitive Surface Mount Devices
J-STD-075	Classification of Non-IC Electronic Components for Assembly Processes
J-STD-609	Marking and Labeling of Components, PCBs and PCBAs to Identify Lead (Pb), Lead-Free (Pb-Free) and Other Attributes.
2011/65/EU	DIRECTIVE 2011/65/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)
2011/37/EU	COMMISSION DIRECTIVE 2011/37/EU of 30 March 2011 amending Annex II to Directive 2000/53/EC of the European Parliament and of the Council on end-of-life vehicles
70/156/EEC	COUNCIL DIRECTIVE of 6 February 1970 on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers

2. Applicability of the PBA DfX Guideline EDM-D-002

- Specification recommendations given in the guideline are intended to help the user in making choices that improve the manufacturability, reliability, testability, etc., of the final PBA. These recommendations are of a generic nature. Therefore, in specific cases more optimal solutions may exist.
- Design specification takes precedence over this guideline.
- IPC class 2 requirements and test procedures apply unless specified otherwise in this document.
- EDM-D-002 supports the selection and specification of electronic component packages in order to guarantee compatibility with the selected soldering process – both thermal load as well as metallurgical aspects – and guarantee basic quality and reliability of the PBA. EDM-D-002 specifications are aimed towards no-clean soldering using lowly activated fluxes for assembly of reliable professional electronics.
- The guideline uses J-STD-001, *Requirements for Soldered Electrical and Electronic Assemblies*, as a basis.
- IPC-HDBK-001, *Handbook and Guide to Supplement J-STD-001*, and IPC-D-279 are recommended reading if more background information is required.