

PBA Design-for-Manufacturing Guideline

EDM-D-003 PBA Assembly Material Specification

V1.3
July 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 realised in collaboration with the industrial and academic partners of imec's Center of Electronics Design & Manufacturing and Sirris.

Funding organisations

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, Belgium
Liad, Breda, The Netherlands
Page Electronica, Poperinge, Belgium
PsiControl, Ieper, Belgium

NEVAT/EMS - Technologiegroep, The Netherlands

Acknowledgement

The following electronic assembly material experts and companies are acknowledged for providing valuable comments on the requirements and recommendations in this document.

AIM Solders, Rhode Island, USA – Karl Seelig
Alpha - Cookson Performance Materials, South Plainfield, NJ, USA – Alan Plant
Balver-Zinn/Cobar, Breda, The Netherlands – Han Raetsen, Harry Trip
Indium, Milton Keynes, UK - Karthik Vijayamadhavan, Guido Lanoye
Interflux, Gent, Belgium – Daniel Werkhoven

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-003.....	6
3. Solder alloy specification.....	7
3.1. Solder alloy composition and impurity levels	7
3.2. Solder alloy selection.....	7
3.3. Solder alloy mixing	9
4. Flux specification	10
4.1. General requirements.....	10
4.2. Flux selection	10
5. Solder paste specification	13
5.1. General Requirements	13
6. Cleaning of flux residues.....	13
6.1. Basic flux residue cleaning requirements.....	13
6.2. Design-for-Cleaning requirements.....	14
6.3. Cleaning for rework and repair	14
7. Non-conductive Adhesives (SMD)	14
7.1. General Requirements	14
7.2. Increased reliability.....	14
8. Coating, encapsulation, staking and repair polymers	15
8.1. General Requirements	15
8.2. Increased reliability.....	15
9. Underfill	16
10. Conductive Adhesives and Films	16
Revisions	17

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.

GR-78-CORE	Generic Requirements for the Physical Design and Manufacture of Telecommunications Products and Equipment
IEC 61189-5	Test methods for electrical materials, interconnection structures and assemblies – Part 5: Test methods for printed board assemblies
IEC 61190-1-1	Attachment materials for electronic assembly – Part 1-1: Requirements for soldering fluxes for high-quality interconnects in electronics assembly
IEC 61190-1-2	Attachment materials for electronic assembly – Part 1-2: Requirements for solder pastes for high-quality interconnections in electronics assembly
IEC 61190-1-3	Attachment materials for electronic assembly – Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications
IPC-3406	Guidelines for Electrically Conductive Surface Mount Adhesives
IPC-3408	General Requirements for Anisotropically Conductive Adhesive Films
IPC-9201	Surface Insulation Resistance Handbook
IPC-CA-821	General Requirements for Thermally Conductive Adhesives
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-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-SM-817	General Requirements for Dielectric Surface Mounting Adhesives
IPC-SM-840	Qualification and Performance Specification of Permanent Solder Mask and Flexible Cover Materials
IPC-TM-650	IPC Test Methods
J-STD-001	Requirements for Soldering and Electronic Assemblies
J-STD-002	Solderability tests for Component leads, Terminations, lugs, terminals and Wires.
J-STD-003	Solderability Tests for Printed Boards
J-STD-004	Requirements for Soldering Fluxes
J-STD-005	Requirements for Soldering Pastes
J-STD-006	Requirements for Electronic Grade Solder Alloys and Fluxed and Non-Fluxed Solid Solders for Electronic Applications
J-STD-020	Moisture/Reflow Sensitivity Classification for Non-hermetic Solid State Surface Mount Devices
J-STD-030	Guideline for Selection and Application of Underfill Material for Flip Chip and Other Micropackages
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

2. Applicability of the PBA DfX Guideline EDM-D-003

- 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.
- The guideline provides requirements and recommendations for assembly materials to manufacture a PBA with a sufficiently low risk of corrosion and/or Surface Insulation Resistance (SIR) failure in typical industrial or professional mission profiles without the need of extensive material and product qualification testing. Third party qualification testing of assembly materials and their application to the PBA is recommended if a higher level of reliability confidence needs to be established.
- The guideline covers the specification of auxiliary assembly materials as to be delivered to the assembly operation. It addresses solder fluxes and fluxed solder materials as well as adhesives, coatings and underfills. SnPb and SnAgCu based solder alloys are covered in this guideline.
- The guideline does NOT specify the properties of these materials in their final state on the fully assembled PBA.
- 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*, is recommended reading if more background information is required.