IPC-9111

2019 - January

Troubleshooting for Printed Board Assembly Processes

An international standard developed by IPC

Association Connecting Electronics Industries

IPC®

The Principles of Standardization

In May 1995 the IPC's Technical Activities Executive Committee (TAEC) adopted Principles of Standardization as a guiding principle of IPC's standardization efforts.

Standards Should:

- Show relationship to Design for Manufacturability (DFM) and Design for the Environment (DFE)
- Minimize time to market
- Contain simple (simplified) language
- Just include spec information
- Focus on end product performance
- Include a feedback system on use and problems for future improvement

Standards Should Not:

- Inhibit innovation
- Increase time-to-market
- Keep people out
- Increase cycle time
- Tell you how to make something
- Contain anything that cannot be defended with data

Notice

IPC Standards and Publications are designed to serve the public interest through eliminating misunderstandings between manufacturers and purchasers, facilitating interchangeability and improvement of products, and assisting the purchaser in selecting and obtaining with minimum delay the proper product for his particular need. Existence of such Standards and Publications shall not in any respect preclude any member or nonmember of IPC from manufacturing or selling products not conforming to such Standards and Publication, nor shall the existence of such Standards and Publications preclude their voluntary use by those other than IPC members whether the standard is to be used either domestically or internationally.

Recommended Standards and Publications are adopted by IPC without regard to whether their adoption may involve patents on articles, materials, or processes. By such action, IPC does not assume any liability to any patent owner, nor do they assume any obligation whatever to parties adopting the Recommended Standard or Publication. Users are wholly responsible for protecting themselves against all claims of liabilities for patent infringement.

IPC Position Statement on Specification Revision Change

It is the position of IPC's Technical Activities Executive Committee that the use and implementation of IPC publications is voluntary and is part of a relationship entered into by customer and supplier. When an IPC publication is updated and a new revision is published, it is the opinion of the TAEC that the use of the new revision as part of an existing relationship is not automatic unless required by the contract. The TAEC recommends the use of the latest revision. Adopted October 6, 1998

Why is there a charge for this document?

Your purchase of this document contributes to the ongoing development of new and updated industry standards and publications. Standards allow manufacturers, customers, and suppliers to understand one another better. Standards allow manufacturers greater efficiencies when they can set up their processes to meet industry standards, allowing them to offer their customers lower costs.

IPC spends hundreds of thousands of dollars annually to support IPC's volunteers in the standards and publications development process. There are many rounds of drafts sent out for review and the committees spend hundreds of hours in review and development. IPC's staff attends and participates in committee activities, typesets and circulates document drafts, and follows all necessary procedures to qualify for ANSI approval.

IPC's membership dues have been kept low to allow as many companies as possible to participate. Therefore, the standards and publications revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards and publications, why not take advantage of this and the many other benefits of IPC membership as well? For more information on membership in IPC, please visit www.ipc.org or call 847/597-2809.

Thank you for your continued support.

IPC-9111

Troubleshooting for Printed Board Assembly Processes

Developed by Assembly Process Effects Handbook Subcommittee (7-23) of the Process Control Management Committee (7-20) of IPC

Users of this publication are encouraged to participate in the development of future revisions.

Contact:

IPC
3000 Lakeside Drive, Suite 105N
Bannockburn, Illinois
60015-1219
Tel 847 615.7100
Fax 847 615.7105

This Page Intentionally Left Blank

Acknowledgment

Any document involving a complex technology draws material from a vast number of sources across many continents. While the principal members of the Assembly Process Effects Handbook Subcommittee (7-23) of the Process Control Management Committee (7-20) are shown below, it is not possible to include all of those who assisted in the evolution of this standard. To each of them, the members of the IPC extend their gratitude.

Process Control Management Committee

Chair
Michael V. Carano
RBP Chemical Technology, Inc.

Assembly Process Effects Handbook Subcommittee

Co-Chairs
Sharon T. Ventress
U.S. Army Aviation & Missile Command

Sharissa Johns
Lockheed Martin Missiles & Fire Control

Technical Liaison of the IPC Board of Directors

Bob Neves
Microtek Laboratories

Assembly Process Effects Handbook Subcommittee

Lionel Fullwood

Greg Hurst

Bruce Hughes, AMRDEC MS&T EPPT

James (Chunguang) Liu, Asian Centre for Aerospace

Joseph Kane, BAE Systems

Agnieszka Ozarowski, BAE Systems

Zenaida Valianu, Celestica International L.P.

Laura Cohen, Continental Automotive Systems

John Thompson, FCI USA, Inc.

Eric Camden, Foresite, Inc.

Terry Munson, Foresite, Inc.

John Mastorides, Honeywell Aerospace

Hikmat Chammas, Honeywell Inc. Air Transport Systems

Carol Jeffcoate, Honeywell International - Torrance

Michael Yuen, Honghfujin Precision Industry (Shenzhen) Co., Ltd.

Mark Northrup, IEC Electronics Corp.

Doug Amir, Intel Corporation

Rayyomand Aspandiar, Intel Corporation

Ife Hsu, Intel Corporation

Jagadeesh Radhakrishnan, Intel Corporation

Qinglei Zhang, Intel Corporation

Toshiyasu Takei, Japan Unix Co., Ltd.

Joseph Riendeau, Jet Propulsion Laboratory

Shantanu Joshi, Koki Solder America Inc.

Frederick Beltran, L3 Communications

Theodore Lasell, L3 Communications

Bradley Toone, L3 Communications

Robert Fornefeld, L3 Technologies

Shelley Holt, L3 Technologies

Vijay Kumar, Lockheed Martin Missile & Fire Control

Sharissa Johns, Lockheed Martin Missiles & Fire Control

Linda Woody, LWC Consulting

Dennis Fritz, MacDermid Enthone Electronics Solutions

Michael Durkan, Mentor Graphics Corporation

Daniel Foster, Missile Defense Agency

Edward Rios, Motorola Solutions

Bhanu Sood, NASA Goddard Space Flight Center

Andrew Gangler, Naval Surface Warfare Ctr

Aaron Pedigo, Naval Surface Warfare Ctr

Joseph Sherfick, Naval Surface Warfare Ctr

Randy McNutt, Northrop Grumman Aerospace Systems

William Coleman, Photo Stencil

Harold Ellison, Quantum Corporation

Ray Prasad, Ray Prasad Consultancy Group

Bennett Burke, Raytheon Company

James Daggett, Raytheon Company

Melissa Durfee, Raytheon Company

Richard Iodice, Raytheon Company

Fonda Wu, Raytheon Company

Lance Brack, Raytheon Missile Systems

Kathy Johnston, Raytheon Missile Systems

Michael Wolverton, Raytheon Systems Company

David Adams, Rockwell Collins

Nate Grinvalds, Rockwell Collins

Rachel Grinvalds, Rockwell Collins

David Hillman, Rockwell Collins

Douglas Pauls, Rockwell Collins

Casimir Budzinski, Safari Circuits Inc.

Vern Solberg, Solberg Technical Consulting

Andy Bester, U.S. Army Aviation & Missile Command

David Carlton, U.S. Army Aviation & Missile Command

Calette Chamness, U.S. Army Aviation & Missile Command

Sharon Ventress, U.S. Army Aviation & Missile Command

Stephen Meeks, ViaSat

Table of Contents

Table of Contents
Section 1

This Page Intentionally Left Blank

Troubleshooting for Printed Board Assembly Processes
Section 1 – General Introduction

1_GENERAL INTRODUCTION

The Process Effects Committee of the IPC has developed this Process Control Handbooks for Printed Board Manufacture and Assembly, which is a documentation of problems, process causes, and the possible corrective action that may be taken. The inputs were voluntarily established by technical representatives of IPC member companies and have been reviewed in open discussion at the Process Effects Handbook meetings prior to publication.

New inputs are encouraged to help assure that the future Process Control Handbooks are complete and match the latest state-of-the-art in a particular subject.

1.1 Purpose and Format

The purpose of this Handbook is to provide guidance in the form of troubleshooting examples, process cause and effect information and statistical methods for correcting problems in all areas relating to the design, manufacture, assembly, and test of printed wiring products. A comprehensive Table of Contents deals with all of the various aspects of the design through delivery cycle.

The Guideline has been segmented into 16 major sections:

Section	Topic Descriptions	Comments
1	General information	Terminology
2	Documentation	Assembly drawing, Bill of Materials (BOM), Specification Control details, work instructions, routers, Specifications
3	Tooling and Fixturing	Stencils, Holding devices, Calipers, Torque devices
4	Handling and Storage	Materials, PWBs, and components
5	Assembly Material	Solder, flux, paste, adhesive, encapsulation
6	Mechanical Operation	Stenciling, paste deposition, conveyorization
7	Component Preparation	Lead forming and trimming, verification, and kitting
8	Component Mounting Site Preparation	Land pattern redressing, solder dotting, adhesive application, solder jetting
9	Component Placement	Insertion, SMT, bare die
10	Component Attachment	Reflow, wave solder, fountain soldering, hand soldering, welding, surface contact, press fit
11	Cleaning	Manual and automated; in-process and final
12	Coating and Marking	Conformal coating, assembly serialization, and labels
13	Inspection	Visual, magnification, measurement, go/no-go, x-ray
14	Testing	In-circuit, physical, end-use, material testing
15	Reliability Stress Conditioning	Thermal Cycling, Vibration, Humidity Testing