

IPC-WP-023

2018 - May

IPC Technology Solutions White Paper on Performance-Based Printed Board OEM Acceptance

Via Chain Continuity Reflow Test: The Hidden Reliability Threat — Weak Microvia Interface

A Technology Solutions White Paper developed by IPC

Association Connecting Electronics Industries



Copyright Association Connecting Electronics Industries
Provided by IHS Markit under license with IPC
No reproduction or networking permitted without license from IHS
Full document details: IPC WP-023 2018

Licensee=/, User=,
Not for Resale,



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 also 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.

©Copyright 2018. IPC, Bannockburn, Illinois. All rights reserved under both international and Pan-American copyright conventions. Any copying, scanning or other reproduction of these materials without the prior written consent of the copyright holder is strictly prohibited and constitutes infringement under the Copyright Law of the United States.



IPC-WP-023

IPC Technology Solutions White Paper on Performance- Based Printed Board OEM Acceptance

Via Chain Continuity Reflow Test: The Hidden Reliability Threat – Weak Microvia Interface

Developed by the Technology Solutions Committee (V-TSL) 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
60015-1249
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 Technology Solutions Committee (V-TSL) of IPC 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.

Technology Solutions Committee

Chairman
Michael Carano
RBP Chemical Technology, Inc.

Technical Liaison of the IPC Board of Directors

Bob Neves
Microtek (Changzou) Laboratories

Technology Solutions Committee

John Andresakis, Park Electrochemical Corp.

Don Dupriest, Lockheed Martin
Missiles & Fire Control

Dennis Fritz, SAIC

Hardeep Heer, FTG Circuits

David Hillman, Rockwell Collins

Rajesh Kumar, TTM Technologies

Robert Neves, Microtek (Changzhou)
Laboratories

IPC-WP-117 Contributors

IPC Technology Solutions White Papers are developed by teams of subject matter experts (SMEs) and then approved by the IPC Technology Solutions Committee. IPC thanks the author and technical editors who developed this white paper.

Author

Jerry Magera, Motorola Solutions

Technical editors

Michael Carano, RBP Chemical Technology, Inc.

Marc Carter, SAIC

Joseph Fjelstad, Verdant Electronics

Dennis Fritz, SAIC

Jeff Harms, Naval Surface Warfare Center

Happy Holden

Ted Jones, Naval Surface Warfare Center

This Page Intentionally Left Blank

IPC-WP-023, IPC Technology Solutions White Paper on Performance-Based Printed Board OEM Acceptance Via Chain Continuity Reflow Test: The Hidden Reliability Threat — Weak Microvia Interface

A white paper report developed by the V-TSL Technology Solutions Committee

Executive Summary

The proliferation of copper-filled stacked microvias in printed boards has resulted in the emergence of a hidden reliability threat — a weak interface between microvia target pads and electrolytic copper fill. When subjected to thermal stress associated with reflow soldering, weak target pad interfaces are susceptible to fracture. Unfortunately, these weak microvias are often not detectable by electrical tests conducted at ambient temperature and can manifest as intermittent failures in service. Thus, weak microvias pose a significant risk as potential latent defects.

Traditional quality conformance inspection (microsection inspection) does not consistently reveal the weak interfaces. Segments of the industry have adopted rigorous daisy-chain-based simulated assembly reflow tests with continuous resistance monitoring (e.g., IPC-TM-650 Test Method 2.6.27) to screen product with weak microvias, but these tests do not address the underlying cause(s) of weak microvia interfaces.

The myriad number of design, material, process and test variables that affect microvia integrity make in-house design of experiments (DOEs) prohibitively expensive. As a result, there is a lack of published information that quantitatively address the factors that contribute to microvia interface separation.

This white paper asserts that stacked microvia reliability problems warrant a collaborative industry effort to better understand underlying process deficiencies, establish appropriate test and inspection protocols and establish resources to facilitate failure analysis efforts. Although this problem is associated with stacked microvias, it has been encountered in as little as one-layer deep constructions.

The IPC Technology Solutions Committee recognizes that this white paper is a first in what could potentially be several white papers or technical reports and could also lead to collaborative industry efforts to develop solutions to this problem. The committee seeks your feedback on this paper and to know your issues with stacked microvia reliability. You are encouraged to email your feedback, issues and questions to TechnologySolutions@ipc.org.

Introduction

The proliferation of copper-filled stacked microvias in printed boards has resulted in the identification of a hidden reliability threat – a weak interface between the microvia target pad and the electrolytic copper fill. When thermally stressed, the generally weak interface fractures. This is manifest especially during forced convection assembly reflow. Unfortunately, the reflow-induced latent defect cannot be detected by in-circuit tests (ICT). Only after the product is deployed does the stealth threat eventually reveal itself. The latent fault is most commonly identified as an intermittent or complete failure; often well before expected wear-out. Reflow-damaged stacked microvias act much like mechanical switches that open and close with transient thermomechanical strains that accompany operation. Failures were observed between the copper fill and target pad; this is the weak interface.

In day-to-day production, printed boards must survive forced convection heating required for assembly reflow. If they cannot survive, they are worthless. The fundamental objective of assembly reflow is to secure component attachment with solder while not stressing the printed board beyond limits where damage to the printed board can be expected to occur. It is well recognized in the industry that assembly reflow subjects the printed board to the greatest thermal excursion.

Applicable Documents

IPC-TM-650 Test Methods Manual

2.6.27 Thermal Stress, Convection Reflow Assembly Simulation

2.3.8 Flammability, Flexible Insulating Materials

Acronyms List

BGA - Ball grid array

CITC - Current-induced temperature cycle

DOE - Design of experiments

EDX - Energy-dispersive X-ray spectroscopy

FIB - Focused ion beam

ICT - In-circuit test

ITRI - Interconnection Technology Research Institute

MRTV - Motorola Reliability Test Vehicle

PI - Polyimide

PPE - Polyphenyl ether

PPO - Polyphenylene oxide

PTFE - Polytetrafluoroethylene

PTH - Plated-through hole

PTV - Plated-through via

SCV - Subcomposite via

SEM - Scanning electron microscope

T_g - Glass transition temperatures

UV - Ultraviolet

XPS - X-ray photoelectron spectroscopy