



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

IPC-9504

Assembly Process Simulation for Evaluation of Non-IC Components (Preconditioning Non-IC Components)

ANSI/IPC-9504

June 1998

A standard developed by IPC

2215 Sanders Road, Northbrook, IL 60062-6135

Tel. 847.509.9700 Fax 847.509.0700
AVA Documents
www.ipc.org



Document Sharing Hub

The Principles of Standardization

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

Standards Should:

- Show relationship to DFM & 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 (TAEC) 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 standard/guideline 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 standard?

Your purchase of this document contributes to the ongoing development of new and updated industry standards. 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 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 in order to allow as many companies as possible to participate. Therefore, the standards revenue is necessary to complement dues revenue. The price schedule offers a 50% discount to IPC members. If your company buys IPC standards, 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 847/790-5372.

Thank you for your continued support.



ASSOCIATION CONNECTING
ELECTRONICS INDUSTRIES

ANSI/IPC-9504

Assembly Process Simulation for Evaluation of Non-IC Components (Preconditioning Non-IC Components)

Developed by the Component & Process Compatibility Task Group
(5-21c) of the Assembly & Joining Processes Committee (5-20) of IPC

APPROVED OCTOBER 7, 1998 BY



AMERICAN NATIONAL STANDARDS INSTITUTE

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

Contact:

IPC
2215 Sanders Road
Northbrook, Illinois
60062-6135
Tel 847 509.9700
Fax 847 509.9798



Documents

Document Sharing Hub

Acknowledgment

Any Standard involving a complex technology draws material from a vast number of sources. While the principal members of the Component & Process Compatibility Task Group (5-21c) of the Assembly & Joining Processes Committee (5-20) 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.

Assembly & Joining Processes Committee	Component & Process Compatibility Task Group	Technical Liaison of the IPC Board of Directors
Chairman Jim Reed Raytheon Systems	Chairman E. Lon Smith Lucent Technologies Inc.	Stan Plzak Pensar Corp.

Component & Process Compatibility Task Group

Brian Bradford, NORTEL	Richard Shook, Lucent Technologies Inc.	Jack McCullen, Intel Corporation
Leo Feinstein, Allegro Microsystems Inc.	Nick Virmani, NASA/Goddard Space Flight Center	D. Elaine Pope, Intel Corporation
Michele J. DiFranza, The Mitre Corp.	Werner Engelmaier, Engelmaier Associates, Inc.	Jerald G. Rosser, Raytheon Missile Systems Company
Erin K. Yaeger, Loctite Corporation	Mark A. Kwoka, Harris Corp.	Joseph Candella, Senior Systems Technology Inc.
Karen A. Tellefsen, Alpha Metals Inc.	Ronald A. Hollandsworth, ITT Aerospace Communications	Samuel J. Croce, Litton Aero Products Division
Ralph W. Taylor, Lockheed Martin Corporation	Terry L. Munson, CSL Inc.	John Tsutsui, Rockwell International
Donald Rudy, Lucent Technologies Inc.	Gerald Servais, Delphi Delco Electronics Systems	Munir Haq, Advanced Micro Devices Inc.
David Nicol, Lucent Technologies Inc.	David D. Hillman, Rockwell International	Charles Martin, Hewlett Packard Laboratories
Yulia B. Zaks, Lucent Technologies Inc.	James M. Whitehouse, Plexus Corp.	Rao B. Dayaneni, Hewlett Packard Laboratories
E. Lon Smith, Lucent Technologies Inc.	Timothy Pitsch, Plexus Corp.	Jeff Schaefer, National Semiconductor Corp.
Urmi Ray, Lucent Technologies Inc.	Alan S. Cash, Northrop Grumman Corporation	Randy Walberg, National Semiconductor Corp.
Cheng-Ming Yang, Lucent Technologies Inc.	Steven R. Martell, Sonoscan Inc.	Les Hymes, Les Hymes Associates
John E. Sohn, Lucent Technologies Inc.	William R. Russell, Raytheon TI Systems, Inc.	
Curtis Grosskopf, IBM Corp.	Sue A. Jones, Compaq Computer Corporation	

Table of Contents

1.0 SCOPE	1	10.3 Soldering Process Exposure.....	10
1.1 Non-IC Component Evaluations.....	1	10.3.1 Soldering Process Compatibility Levels.....	10
1.2 Process Limitation.....	1	10.4 Chemical Exposure.....	12
2.0 APPLICABLE DOCUMENTS	1	10.4.1 Water Soluble Flux Exposure	12
2.1 Institute for Interconnecting and Packaging Electronic Circuits (IPC).....	1	10.4.2 Aliphatic or Terpene Hydrocarbon Cleaning.....	13
2.2 Joint Industry Standards.....	1	10.4.3 Aqueous Detergent Total Immersion Cleaning.....	13
2.3 Electronic Industries Association.....	1	10.4.4 Deionized Water Total Immersion Cleaning.....	13
3.0 TERMS AND DEFINITIONS	1	10.5 Acceptance Criteria	13
4.0 APPLICATIONS AND OBJECTIVES	2	11.0 SOLDERING PROCESS COMPATIBILITY MATRIX	13
4.1 Objectives	2		
4.2 Process Simulations.....	2		
4.3 Applications.....	2		
5.0 APPARATUS	3		
6.0 REQUIREMENTS	3		
7.0 RECOMMENDATIONS	3		
8.0 COMPONENT CLASSIFICATION	4		
9.0 COMPONENT STORAGE PROCESS PRECONDITIONING SELECTION AND PROCESS FLOW	4		
10.0 PRECONDITIONING TEST PROCEDURES	9		
10.1 Moisture Exposure	9		
10.1.1 Preliminary Bake.....	9		
10.1.2 Moisture Sensitivity Levels	9		
10.2 Component Placement.....	9		
10.2.1 Application	10		
10.2.2 Application	10		
10.2.3 Application	10		

Figures

Figure 1	Application of IPC-9504	2
Figure 2	Assembly Process Simulation	6
Figure 2	Assembly Process Simulation (continued)	7
Figure 3	Infrared/Convection Reflow Thermal Profile....	10
Figure 4	Wave Solder Thermal Profile (TH Components)	11
Figure 5	Wave Solder Thermal Profile (SM Components).....	12

Tables

Table 1	Moisture Sensitivity Floor Life Levels	4
Table 2	Soldering Process Compatibility Levels Test Conditions.....	5
Table 3	Chemical Compatibility Levels	5
Table 4	Soldering Process Compatability Matrix	14



This Page Intentionally Left Blank

Assembly Process Simulation for Evaluation of Non-IC Components (Preconditioning Non-IC Components)

1.0 SCOPE

1.1 Non-IC Component Evaluations This document describes manufacturing process simulations for use with applicable component specifications to assure that electronic components can meet expected reliability requirements after exposure to assembly factory processes. It is not intended as an assembly production specification or a stand-alone qualification document. The procedure consists of a set of assembly process simulations that can be performed by either the component user or manufacturer prior to reliability testing as specified in the applicable component qualification and reliability monitoring documents. The simulations include alternative conditions depending on the component type, physical characteristics and anticipated use. The levels defined can be used for describing either expected performance characteristics by the manufacturer or the required characteristics for the users assembly process.

It is expected that a single component would be evaluated for a subset of the alternative conditions. For example, large connectors might be qualified utilizing the lower of two reflow temperature ranges while smaller packages, which typically become much hotter during infrared or convection reflow, might be qualified for the higher range. Similarly, components with physical characteristics that prohibit total immersion cleaning would not be evaluated for this type of cleaning process.

Unless otherwise specified, this document applies to both surface-mount (SM) reflowed components and through-hole (TH) components, which are wave soldered or reflowed. For wave solder of SM components, user and supplier should work together to identify appropriate procedures.

1.2 Process Limitation This document is not intended as an assembly production specification. The ranges of times and temperatures for component evaluations are considered to be outside the optimal conditions for assembly processes. The component body temperature, time at maximum temperature, and thermal spike, etc., in the actual assembly process should at no time exceed the lower limits of the specified test conditions with which the component is evaluated per this document.

2.0 APPLICABLE DOCUMENTS

2.1 Institute for Interconnecting and Packaging Electronic Circuits (IPC)¹

IPC-AC-62 Aqueous Cleaning Handbook

IPC-OI-645 Standard for Visual Optical Inspection Aids

IPC-TM-650 Test Methods Manual

Method 2.6.9.1 Test to Determine Sensitivity of Electronic Components to Ultrasonic Energy

IPC-SM-817 General Requirements for Dielectric Surface Mounting Adhesives

2.2 Joint Industry Standards¹

J-STD-002 Solderability Tests for Component Leads, Terminations, Lugs, Terminals, and Wires

J-STD-020 Moisture-Induced Sensitivity Classification for Plastic Integrated Circuit Surface Mount Devices

2.3 Electronic Industries Association²

EIA-541 Packaging Material Standards for ESD Sensitive Items

EIA-625 Requirements for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices

JESD22-A113 Preconditioning of Plastic Surface Mount Devices Prior to Reliability Testing

3.0 TERMS AND DEFINITIONS

Spike The peak temperature of a component lead on the solder side of the board while in contact with molten solder minus its temperature prior to entering the wave. This parameter is also referred to sometimes as the “delta T” or thermal shock.

Ramp Rate Greatest temperature difference in four consecutive seconds in the entire reflow thermal profile divided by four.

1. IPC, 2215 Sanders Road, Northbrook, IL 60062 www.ipc.org
2. EIA, 2500 Wilson Blvd., Arlington, VA 22201

4.0 APPLICATIONS AND OBJECTIVES

4.1 Objectives The objectives of the document are as follows:

- Minimize cost of component qualification by establishing a standardized set of assembly process simulations for use as part of component qualification.
- Facilitate the development and manufacture of robust components by establishing a set of targets for Component/assembly process compatibility.
- Known failure mechanisms should be taken into consideration during the negotiation of the XYZ levels to which the component will be qualified.

The use of this document is illustrated in Figure 1, which shows typical steps and decision points in flow chart form. Future revisions of this document may refer to other classification documents as they become available. A standard set of process preconditioning steps is defined from which an appropriate subset can be selected for verifying the capability of a component to survive specific assembly factory process conditions.

4.2 Process Simulations The process simulated includes the following:

- Component storage and use in specific environments.
- Wave and reflow soldering of both surface-mount and through-hole components.
- Exposure to corrosive fluxes (water soluble).
- Exposure to the currently most prevalent cleaning materials.

4.3 Applications The recommended conditions provide for evaluation of parts for the stresses of board assembly processes. The repetitive solder steps take into account the existence of multiple solder steps and rework operations in typical factories. The recommended sequence provides for evaluation with several flux and cleaning materials in a single test.

Processes for which specific components will not be qualified because of known failure mechanisms should be omitted from the sequence.

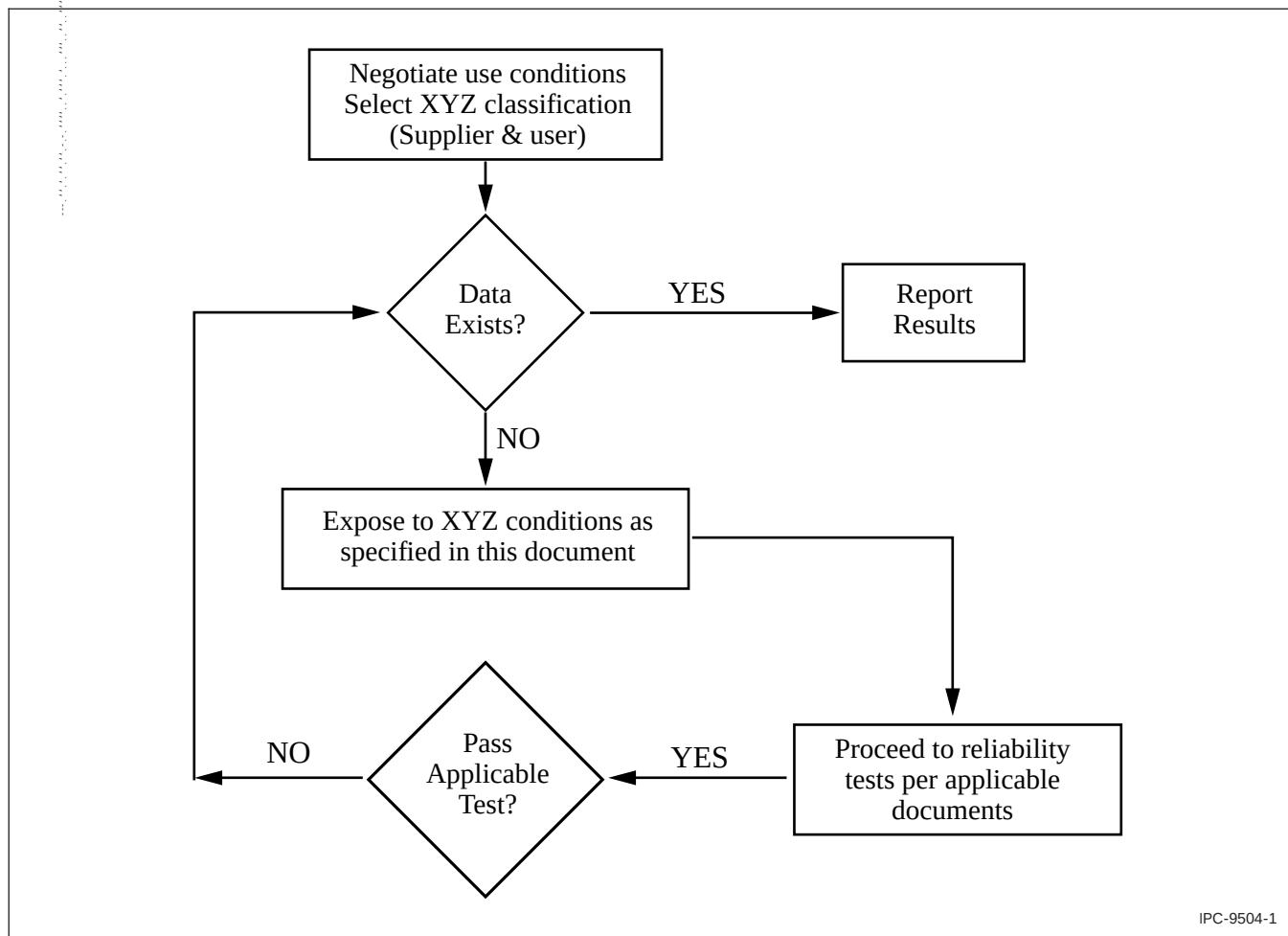


Figure 1 Application of IPC-9504

Qualification for rework is assumed to be done as part of the three replications of the soldering operation. Users must recognize that when any component is certified to one of the classifications in this document at no time in the manufacturing process, including rework, shall the component body temperature be raised above the certified temperature.

5.0 APPARATUS

The following equipment is used in the process exposures described in this document:

5.1 Temperature-Humidity chamber(s) capable of operating at $85 \pm 2^\circ\text{C}/85 \pm 3\% \text{ RH}$, $85 \pm 2^\circ\text{C}/60 \pm 3\% \text{ RH}$ and $30 \pm 2^\circ\text{C}/60 \pm 3\% \text{ RH}$.

5.2 Reflow equipment capable of heating the topside of components to temperatures of 220 and 240°C with a ramp-up 4°C and ramp-down rate that shall be $<6^\circ\text{C}$ per second. The actual ramp rate may depend on component type.

- Convection – Preferred
- IR
- Vapor Phase

5.3 Since flux application is intended to simulate actual processing, flux may be applied by spray, immersion, brushing, or other appropriate method.

5.4 Wave solder or bench top “solder pot” type equipment capable of preheating the component lead on the solder side of the board to 125°C (minimum), heating the solder pot temperature to $260 \pm 5^\circ\text{C}$ at the surface of molten solder, and maintaining that temperature while keeping a component in molten solder for seven seconds (minimum). For through-hole components this equipment must also maintain the component body temperature at the specified temperature (Table 2, levels X3Z, X4Z & X8Z) for at least 10 seconds, if not, an oven capable of maintaining a temperature of $185 \pm 5^\circ\text{C}$ is also needed.

5.5 Cleaning equipment capable of either spraying or immersing components with agitated aliphatic or terpene hydrocarbon at room temperature, aqueous detergent up to 65°C , and DI water up to 65°C .

5.6 Appropriate inspection and test equipment capable of performing requirements of the applicable component specification document.

5.7 Oven capable of operating at $125(+5,-0)^\circ\text{C}$.

5.8 Temperature cycle chamber capable of operating as a minimum over the range of -40°C to $+60^\circ\text{C}$. The chamber used shall be capable of providing and controlling the

specified temperatures in the working zones when the chamber is loaded with a maximum load. Worst-case load temperature shall be continually monitored during test by indicators or recorders reading the monitoring sensor(s). Direct heat conduction to specimens shall be minimized.

6.0 REQUIREMENTS

6.1 Components used in tests shall have completed all normal manufacturing processes prior to shipment, such as labeling, marking, burn-in, etc. and meet incoming requirements such as solderability per J-STD-002 and electrical performance according to device specifications.

6.2 Handling and processing precautions for ESD sensitive components such as described in EIA-541 and EIA-625 shall be followed at all steps on all parts processed per this specification.

7.0 RECOMMENDATIONS

7.1 Visual examination per IPC-OI-645 to identify failures is recommended following process exposure procedures described in 9.3, 9.4, 9.5 and 9.8.

7.2 If a component fails its applicable process exposure sequence, separate experiments to identify which material or process condition caused the failure are recommended.

7.3 Soldering equipment used for thermal exposure of components shall be profiled daily before qualification, to determine that the temperatures consistently meet the requirements given in the applicable parts of 10.3.

7.4 Thermal profile and test data are recommended be kept as part of the permanent record.

7.5 Profiling of soldering equipment can be done as follows:

Fine wire thermocouple (T/C), is most commonly used thermometric sensor to measure temperature profile. Other sensors such as fluoroptic polymer probe, IR fiber optic probe, and phase change material (PCM) may be used.

- For profiling infrared/convection and vapor phase reflow soldering equipment, thermocouples are mounted on the SM and TH component bodies.
- Thermocouples should be mounted with an adhesive with a thermal conductivity similar to the component being monitored and capable of withstanding soldering exposure temperature.
- For profiling wave soldering equipment, thermocouples are mounted on surface mount and through-hole component bodies on the topside of the component.