

**IPC J-STD-004D**

**December 2023**

**Supersedes IPC J-STD-004C WAM1**

**February 2023**

# ***JOINT INDUSTRY STANDARD***

Requirements for  
Soldering Fluxes



**BUILD ELECTRONICS BETTER**

**IPC Mission**

IPC is a global trade association dedicated to furthering the competitive excellence and financial success of its members, who are participants in the electronics industry.

In pursuit of these objectives, IPC will devote resources to management improvement and technology enhancement programs, the creation of relevant standards, protection of the environment, and pertinent government relations.

IPC encourages the active participation of all its members in these activities and commits to full cooperation with all related organizations.

**About IPC Standards**

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 their particular need. Existence of such IPC standards and publications shall not in any respect preclude any entity from manufacturing or selling products not conforming to such IPC standards and publication, nor shall the existence of such IPC standards and publications preclude their voluntary use.

IPC standards and publications are approved by IPC committees without regard to whether the IPC standards or publications may involve patents on articles, materials or processes. By such action, IPC does not assume any liability to any patent owner, nor does IPC assume any obligation whatsoever to parties adopting an IPC 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**

The use and implementation of IPC standards and publications are voluntary and part of a relationship entered into by customer and supplier. When an IPC standard or publication is revised or amended, the use of the latest revision or amendment as part of an existing relationship is not automatic unless required by the contract. IPC recommends the use of the latest revision or amendment.

**Standards Improvement Recommendations**

IPC welcomes comments for improvements to any standard in its library. All comments will be provided to the appropriate committee.

If a change to technical content is requested, data to support the request is recommended. Technical comments to include new technologies or make changes to published requirements should be accompanied by technical data to support the request. This information will be used by the committee to resolve the comment.

To submit your comments, visit the IPC Status of Standardization page at [www.ipc.org/status](http://www.ipc.org/status).



**IPC-J-STD-004D**

# **Requirements for Soldering Fluxes**

If a conflict occurs between the English language and translated versions of this document, the English version will take precedence.

Developed by the 5-24A Flux Specifications Task Group of the Assembly and Joining General Committee 5-20 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  
60015-1249  
Tel 847 615.7100  
Fax 847 615.7105

**Supersedes:**  
IPC-J-STD-004C WAM1  
February 2023

This Page Intentionally Left Blank

## Acknowledgments

Any document involving a complex technology draws material from a vast number of sources across many continents. While the principal members of the 5-24A of the Flux Specifications Task Group Task Group 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.

### 3-20 Assembly and Joining General Committee

Chair

Daniel L. Foster

Missile Defense Agency (MDA)

### 5-24A Flux Specifications Task Group

Chair

Anthony W. Lentz

FCT Assembly, Inc

Vice Chair

Keith Sellers

Element Materials Technology

### Technical Liaison of the IPC Board of Directors

Bob Neves

Microtek (Changzou), Laboratories

Elizabeth A. Allison, NTS - Baltimore

Jasbir Bath, Koki Solder America

Holger Baldreich, Continental Automotive Technologies GmbH

Moriah Bischann, Lockheed Martin

Mike Bixenman, Kyzen Corporation

Henrik Blegvad Jensen, Gaasdal Bygningsindustri A/S

Gerald Leslie Boggert, Bechtel Plant Machinery, Inc.

Lance Brack, Raytheon Missile Systems

Eric Camden, Foresite, Inc.

Eric Campbell, IBM Corporation

Lin Cao, Shenyang Railway Signal Co., Ltd.

William P. Carinal, Collins Aerospace

Zhiman Chen, Zhuzhou CRRC Times Electric Co., Ltd.

Beverly Christian, HDP User Group

Miguel Dominguez, Continental Temic SA de CV

Aurelie Ducoulombier, Inventec Performance Chemicals

John Falecki, Plexus

Tony Feldmeier, Honeywell Aerospace Minneapolis

Daniel L. Foster, Missile Defense Agency (MDA)

Jason Fullerton, Cobham Defense Electronics Systems

Mahendra S. Gandhi, Northrop Grumman Space Systems

Matt Gruber, Indium Corporation

Emmanuelle Guene, Inventec Performance Chemicals

Alafio Hewitt, Lockheed Martine Missile & Fire Control

Gaston Hildago, Toyota Motor North America

Emma Hudson, Emma Hudson Technical Consultancy

Christopher Hunt, Gen3 Systems Limited

Jennie S. Hwang, H-Technologies Group

Logan Johnson, BAE Systems, Inc.

Russell Kido, Practical Components Inc.

Nathan Knipeq, Lockheed Martin Missile & Fire Control

Anthony W. Lentz, FCT Assembly, Inc.

Chris Mahanna, Robisan Laboratory Inc.

Martin Marcel, Wurth Electronics Midcom

Yuri Misumo, Koki Company Limited

Graham Naisbitt, Gen3 Systems Limited

Robert Neves, Microtek Laboratories China

Jose Servin Olivares, Vitesco Technologies

Catalina Pamatmat, Continental Temic Electronic (Phils.)

Douglas O. Pauls, Collins Aerospace

Brian Rundell, Indium

Stanton Rak, Rak Company

Joseph Rousseau, Precision Analytical Laboratory, Inc.

Ole Sandvold, MacDermid Alpha Electronics Solutions

David W. Sbiroli, Indium Corporation

Rachel Schwartz, Insituware LLC

Keith Sellers, Element Materials Technology

Russell S. Shepherd, NTS - Anaheim

Eric Straw, Collins Aerospace

Kirk Van Dreel, Plexus Corp.

Bill R. Vuono, Qorvo US, Inc.

Debbie Wade, Advanced Rework Technology

Dan White, BAE Space Systems

Harlen Wu, TE Connectivity

Chen Xu, Nokia Bell Labs

Cherry Yin, IT electronic integrated manufacturing services (Suzhou Limited)

Arbi Zaied, TEAM Partner

Jon Zettwoch

Paul Zutter, Army Aviation & Missile Command

This Page Intentionally Left Blank

## Table of Contents

<b>1</b>	<b>SCOPE</b> .....	1	2.4.34.4	Paste Flux Viscosity - T-Bar Spindle Method	3
1.1	Purpose .....	1	2.6.1	Fungus Resistance Printed Wiring Materials	3
1.2	Classification .....	1	2.6.3.3	Surface Insulation Resistance (SIR), Fluxes	3
1.3	Measurement Units .....	1	2.6.3.7	Surface Insulation Resistance .....	3
1.4	Definition of Requirements.....	1	2.6.14.1	Electrochemical Migration Resistance Test..	3
1.5	Process Control Requirements.....	1	2.6.15	Corrosion, Flux.....	3
1.6	Order of Precedence.....	2	2.2	Joint Industry Standards.....	3
1.6.1	Conflict.....	2	2.2.1	J-STD-001 .....	3
1.6.2	Clause References.....	2	2.2.2	J-STD-003 .....	4
1.6.3	Appendices .....	2	2.2.3	J-STD-005 .....	4
1.7	Use of “Lead”.....	2	2.2.4	J-STD-006 .....	4
1.8	Abbreviations and Acronyms.....	2	2.3	American Society for Testing and Materials (ASTM) .....	4
1.8.1	ECM .....	2	2.3.1	ASTM D-465-15 .....	4
1.8.2	SIR.....	2	2.4	British Standards .....	4
1.9	Terms and Definitions .....	2	2.4.1	EN 14582.....	4
1.9.1	Halide.....	2	2.5	International Organization for Standards.....	4
1.9.2	Halogen.....	2	2.5.1	ISO 9001-2000 .....	4
1.9.3	Low Halogen Flux (Cl and Br).....	2	2.6	National Conference of Standards Laboratories (NCSL).....	4
1.9.4	Flux Composition.....	3	2.6.1	ANSI-NCSL-Z540-1.....	4
1.9.5	Supplier.....	3			
<b>2</b>	<b>APPLICABLE DOCUMENTS</b> .....	<b>3</b>	<b>3</b>	<b>GENERAL REQUIREMENTS</b> .....	<b>4</b>
2.1	IPC .....	3	3.1	Designation .....	4
IPC-T-50	Terms and Definitions for Interconnecting and Packaging Electronic Circuits.....	3	3.2	Flux Qualification.....	5
IPC-9191	General Guidelines for the Implementation of Statistical Process Control.....	3	3.2.1	Classification .....	6
IPC-TM-650	Test Methods Manual.....	3	3.2.1.1	Flux Composition.....	6
2.3.13	Determination of Acid Value of Liquid Solder Flux - Potentiometric and Visual Titration Methods .....	3	3.2.1.2	Flux Type.....	6
2.3.28.1	Halide Content of Soldering Fluxes and Pastes .....	3	3.2.1.2.1	Flux Activity .....	6
2.3.32	Flux Induced Corrosion (Copper Mirror Method) .....	3	3.2.1.2.2	Halide Content.....	6
2.3.33	Presence of Halides in Flux, Silver Chromate Method.....	3	3.2.2	Characterization.....	7
2.3.34	Solids Content, Flux.....	3	3.3.1	Classification Testing .....	7
2.3.35.1	Fluorides by Spot Test, Fluxes - Qualitative..	3	3.3.1.1	Copper Mirror Test.....	7
2.4.14.2	Liquid Flux Activity, Wetting Balance Method.....	3	3.3.1.2	Corrosion Test .....	7
			3.3.1.3	Quantitative Halide Content Tests.....	8
			3.3.1.4	SIR Test. ....	8
			3.3.1.4.2	SIR Test Criteria .....	8
			3.3.1.5	Resistance to ECM Testing .....	9
			3.3.1.5.1	Reporting ECM Test Results.....	9
			3.3.2	Characterization Testing.....	9

3.3.2.1	Flux Solids (Non-volatile) Determination ....	9	4.1.1.1	Quality Assurance Program .....	11
3.3.2.2	Acid Value Determination.....	9	4.1.2	Test Equipment and Inspection Facilities... 11	
3.3.2.3	Specific Gravity Determination .....	9	4.1.3	Inspection Conditions.....	11
3.3.2.4	Viscosity of Paste (Tacky) Flux .....	9	4.2	Types of Inspections .....	11
3.3.2.5	Visual .....	9	4.3	Qualification Inspection .....	12
3.4	Optional Testing .....	9	4.3.1	Sample Size .....	12
3.4.1	Optional Qualitative Halide Tests .....	9	4.3.2	Inspection Routine.....	12
3.4.1.1	Optional Chlorides and Bromides by Silver Chromate Method.....	9	4.3.3	Requalification .....	12
3.4.1.2	Optional Fluorides By Spot Test.....	9	4.3.3.1	Formula Variations Constituting Material Change .....	12
3.4.2	Optional SIR Tests.....	10	4.3.3.2	Manufacturing Site Change .....	12
3.4.2.1	Reporting Values for Optional SIR Test Methods.....	10	4.4	Quality Conformance Inspection.....	12
3.4.3	Optional Fungus Resistance Test.....	10	4.4.1	Sampling Plan .....	12
3.4.4	Optional Halogen Content Test.....	10	4.4.2	Rejected Lots .....	12
3.4.5	Optional Resistance to Creep Corrosion Testing. ....	10	4.5	Performance Inspection.....	12
3.5	Quality Conformance Testing .....	10	4.6	Statistical Process Control (SPC).....	12
3.5.1	Acid Value Determination.....	10	B-1	Cleaning and Test Methods.....	15
3.5.2	Specific Gravity Determination .....	10	B-2	Ordering Data .....	15
3.5.3	Viscosity of Paste (Tacky) Flux. ....	10	B-3	Formic Acid.....	15
3.5.4	Visual .....	10	B-4	Wetting Balance Test Guidance .....	15
3.6	Performance Testing.....	10	B-5	Extension of Shelf Life for Liquid Flux ....	16
3.6.1	Wetting Balance Test.....	10	B-6	REACH.....	16
<b>4</b>	<b>QUALIFICATION AND QUALITY ASSURANCE PROVISIONS.....</b>	<b>10</b>	B-7	Halide versus Halogen Content .....	16
4.1	Responsibility for Inspection .....	11	B-8	Restriction of Hazardous Substances (RoHS).....	16
4.1.1	Responsibility for Compliance. ....	11	B-9	SIR Testing: Chamber conditions' effect on SIR results. ....	16

<b>Figures</b>		<b>Tables</b>	
Figure 3-1	Flux Corrosivity by Copper Mirror Test..... 7	Table 3-1	Flux Identification System and Test Requirements for Flux Classification.... 5
Figure 3-2	Example of No Corrosion ..... 8	Table 3-2	Preparation of Flux Forms for Testing..... 6
Figure 3-3	Example of Minor Corrosion..... 8	Table 3-3.	Quantitative Halide and Activity Classification ..... 7
Figure 3-4	Example of Major Corrosion ..... 8	Table 3-4	Halogen Content in Low Halogen Materials ..... 10
Figure B-1	Typical Wetting Balance Curve..... 15	Table 4-1	Qualification, Quality Conformance and Performance Testing for Flux ..... 11
Figure D-1A and D-1B	ImmAg board from a consumer product after 5 days Mixed Flowing Gas exposure [1] .... 18		Required Cleaning Information if the Flux was Removed. .... 14
		Table D-1.	Comparison Between MFG and FoS Tests for Creep Corrosion..... 20

This Page Intentionally Left Blank

# IPC-J-STD-004D

## Requirements for Soldering Fluxes

---

### 1 SCOPE

This standard prescribes general requirements for the classification and characterization of fluxes for high quality solder interconnections. This standard may be used for quality control and procurement purposes.

**1.1 Purpose** The purpose of this standard is to classify and characterize Sn/Pb and Pb-free soldering flux materials for use in electronic metallurgical interconnections for printed board assembly. Soldering flux materials include the following: liquid flux, paste flux, solder paste, solder cream as well as flux-coated and flux-cored solder wires and preforms. The fluxes involved relate to all aspects of application, such as: printed board fabrication, lead tinning, wave soldering, reflow and rework. Fluxes covered by this standard are intended for use in various applications in industry. It is not the intent of this standard to exclude any acceptable flux or soldering material; however, these materials must produce the desired electrical and metallurgical interconnection.

### 1.2 Classification

**CLASS 1 General Electronic Products** Includes products suitable for applications where the major requirement is function of the completed assembly.

**CLASS 2 Dedicated Service Electronic Products** Includes products where continued performance and extended life is required, and for which uninterrupted service is desired but not critical. Typically, the end-use environment would not cause failures.

**CLASS 3 High Performance/Harsh Environment Electronic Products** Includes products where continued high performance or performance-on-demand is critical, equipment downtime cannot be tolerated, end-use environment may be uncommonly harsh, and the equipment must function when required, such as life support or other critical systems.

**1.3 Measurement Units** All dimensions and tolerances in this specification are expressed in hard SI (metric) units and bracketed soft imperial [inch] units. Users of this specification are expected to use metric dimensions. All dimensions  $\geq 1$  mm [0.0394 in] will be expressed in millimeters and inches. All dimensions  $< 1$  mm [0.0394 in] will be expressed in micrometers and microinches.

**1.4 Definition of Requirements** The words **shall** or **shall not** are used in the text of this document wherever there is a requirement for materials, preparation, process control or acceptance.

The word “should” reflects recommendations and is used to reflect general industry practices and procedures for guidance only.

Line drawings and illustrations are depicted herein to assist in the interpretation of the written requirements of this Standard. The text takes precedence over the figures.

**1.5 Process Control Requirements** The primary goal of process control is to continually reduce variation in the processes, products, or services to provide products or processes meeting or exceeding User requirements. Process control tools such as IPC-9191, JESD557 or other User-approved system may be used as guidelines for implementing process control.

Manufacturers of Class 3 products **shall** develop and implement a documented process control system.

A documented process control system, if established, **shall** define process control and corrective action limits.

This may or may not be a statistical process control system. The use of “statistical process control” (SPC) is optional and should be based on factors such as design stability, lot size, production quantities, and the needs of the Manufacturer, see 4.6.

Process control methodologies **shall** be used in the planning, implementation and evaluation of the manufacturing processes used to produce soldered electrical and electronic assemblies. The philosophy, implementation strategies, tools and techniques may be applied in different sequences depending on the specific company, operation, or variable under consideration to relate process control and capability to end product requirements.

When a decision or requirement is to use a documented process control system, failure to implement process corrective action and/or the use of continually ineffective corrective actions would be grounds for disapproval of the process and associated documentation.