

IPC J-STD-004B
Amendment 1
November 2011

JOINT INDUSTRY STANDARD

Requirements for
Soldering Fluxes

Amendment 1



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Editorial Change

1.2 Purpose The purpose of this standard is to classify and characterize tin/lead and lead-free soldering flux materials for use in electronic metallurgical interconnections for printed circuit 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. 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.

Change in Note 1

Table 1-1 Flux Identification System

Note 1. Halide measuring <0.05% by weight in flux solids may be known as halide-free. The quantitative halide method determines the amount of halide present (see Appendix B-10).

Remove the Prefix BS from the Document Number

2.4 British Standards

EN 14582 Characterization of waste. Halogen and sulfur content. Oxygen combustion in closed systems and determination methods.

Insert 5 New Paragraphs

3.2.4 Halide In this standard, halogen ions are known as halides. Specifically, chlorine ion is known as chloride or (Cl⁻), bromine ion is known as bromide or (Br⁻), fluorine ion is known as fluoride or (F⁻), iodine ion is known as iodide or (I⁻) and halogen compounds that have ionic character are termed halide compounds.

3.2.5 Halogen In this standard, halogen is the term for all chlorine (Cl) and/or bromine (Br) in compounds. These two types of compounds are referenced based upon the EN 14582 test method (see 3.5.4).

3.2.6 Low Halogen Flux (Cl and Br) For the purpose of this standard, low halogen materials contain ≤1000 ppm (0.1%) Br, and ≤1000 ppm (0.1%) Cl. Sample preparation should be AABUS.

3.2.7 Resin Flux Primarily composed of synthetic resins and/or natural resins other than rosin types.

3.2.8 Rosin Flux Primarily composed of natural rosin, extracted from the oleoresin of pine trees and refined. The rosins used shall have a minimum acid value of 130 as determined per ASTM D-465. A synonym for rosin is colophony.

Insert Row at the Bottom of the Table and Replace Note 1

Table 3-1 Preparation of Flux Forms for Testing

Halogen Content	Flux residue after reflow	Flux residue after reflow	Flux residue after reflow; metal removed	Flux residue after reflow; metal removed	Flux residue after reflow; metal removed
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1. Testing an as-received flux containing >50% water may give a failing result due to the presence of water, so it may be oven dried at 80° ± 2°C for 1 hour +15 minutes/-0 minutes and reconstituted (dissolved in the appropriate solvent) per IPC-TM-650, Method 2.3.32 for use in this test. If the sample is tested in the reconstituted state, results from both the as-received and reconstituted samples shall be reported.

Change Paragraph

3.3.1.2.2 Halide Content Flux Type shall be identified using 0 or 1 to indicate the absence or presence of halide in the flux, where <0.05% halide is defined as halide free. The absence or presence of halide shall be determined per the test method outlined in Table 3-2 and the corresponding paragraphs. The quantitative halide method determines the amount of halide present (see Appendix B-10). Testing for halide content does not include evaluation for halogen content. A material with a “0” indicator may contain non-ionic halogen. See 3.2.4 and 3.2.5.

*Editorial Change to Note 1.***Table 3-2 Test Requirements for Flux Classification**

Note 1. This method determines the amount of halide present (see Appendix B-10).

Replace Paragraph

3.4.1.3 Quantitative Halide Content Tests Quantitative halide tests **shall** be used to determine the concentration of chloride (Cl⁻), bromide (Br⁻), fluoride (F⁻) and iodide (I⁻) in liquid fluxes or extracted flux solutions. The total halide content of the flux is obtained by adding together the Cl⁻, Br⁻, F⁻, and I⁻ contents. The halide content is reported as the weight percentage of halide of the solid (nonvolatile) portion of the flux. The combined concentration of chlorides, bromides, fluorides, and iodides **shall** be determined in accordance with IPC-TM-650, Test Method 2.3.28.1. The solids content is determined in accordance with 3.4.2.1.

*Replace First Bullet Point***3.4.1.4.1 Reporting SIR Test Results**

- All SIR measurements on all test patterns **shall** exceed the 100 MΩ requirement after 24 hours of exposure.

Editorial Change

3.4.1.5 Resistance to ECM Testing The resistance to ECM testing **shall** be assessed in accordance with IPC-TM-650, Test Method 2.6.14.1, using the 65°C ± 2°C, 88.5% ± 3.5% RH condition. ECM patterns **shall** be prepared per IPC-TM-650, Method 2.6.3.3 using the product-specific reflow or wave soldering profile.

Editorial Change

3.5.1.1 Optional Chlorides and Bromides by Silver Chromate Method The presence of chlorides and bromides may be determined in accordance with IPC-TM-650, Test Method 2.3.33.

Editorial Change

3.5.1.2 Optional Fluorides by Spot Test The presence of fluorides may be determined in accordance with IPC-TM-650, Test Method 2.3.35.1.

Insert New Paragraph

3.5.4 Optional Halogen Content Test When reporting of halogen content is requested, the concentration of Cl and Br **shall** be determined using the EN 14582 oxygen bomb method followed by ion chromatography per IPC-TM-650, Method 2.3.28.1. Alternate test methods may be used AABUS. Halogen levels measured are impacted by the sample preparation method selected; therefore, specific sample preparation details **shall** be included in the test report (see Appendix A). Flux materials that do not contain metal **shall** be tested in the final reflowed residue form. Samples that contain metal **shall** be reflowed or extracted to obtain the flux portion of the material. The metal must be discarded and weight of the metal should not be considered in the calculation for halogen content. Alternate sample types (e.g., testing of raw flux) may give varying results and **shall** be AABUS. A flux residue is considered low halogen if the maximum halogen values are in accordance with Table 3-3.

*Insert New Table***Table 3-3 Halogen Content in Low Halogen Materials**

Maximum Quantitative Halogen
≤1000 ppm (0.1%) Br, and ≤1000 ppm (0.1%) Cl

Insert a New Row Between “Fungus” and “Wetting Balance”

Table 4-1 Qualification, Quality Conformance and Performance Testing for Flux

Halogen Content	EN 14582	3.5.4	O		
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Appendix A Example Qualification Test Report

Add “Note” Superscript to SIR and ECM

SIR ¹	3.4.1.4	2.6.3.7	No-clean state $\geq 100 \text{ M}\Omega$	L	___ L
			Cleaned or no-clean state $\geq 100 \text{ M}\Omega$	M	___ M
			Cleaned $\geq 100 \text{ M}\Omega$	H	___ H
ECM ¹	3.4.1.5	2.6.14.1	No-clean < 1 decade drop	L	___ L
			Cleaned or no-clean < 1 decade drop	M	___ M
			Cleaned < 1 decade drop	H	___ H

Add New Row Between “Fungus (Optional)” and “Wetting Balance (Optional)”

Halogen ²	3.5.4	EN 14582		
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Add New Notes 1 and 2 for Example Qualification Test Report**Note 1:**

Required Information for Cleaned Product	
Cleaning Procedure for SIR/ECM Testing:	
Cleaning Material:	
Cleaning Equipment:	
Cleaning Process Parameters:	

Note 2:

Required Information for Halogen Determination	
Procedure used to extract metal, if applicable	
Reflow Profile	
Substrate used to collect reflowed sample residue	
Reflow Atmosphere	
Halogen Determination via Ion Chromatography	Weight of ion (g) in sample = $[Conc. \text{ of Ion in Extract } (\mu\text{g} / \text{mL})] \times [Dilution \text{ Factor}] \times [Dilution \text{ Volume (mL)}] \times 10^{-6}$ Percent of ion in residue = $\frac{Wt \text{ of Ion (g) in Sample}}{Wt \text{ (g) of Fluxresidue}} \times 100$

Appendix B Notes***Remove Prefix BS from Document Number BS-EN 14582***

B-10 Halide versus Halogen Content IPC-TM-650, Method 2.3.28.1, is intended for the detection of ionic halides. Ionic halide content is not to be confused with halogen content. Halogen content should be tested per EN 14582 or AABUS. An Oxygen Bomb is utilized to dissociate the covalently bound halide and this product is dissolved and analyzed via ion chromatography. For additional information see *A Review of Test Methods and Classifications for Halogen-Free Soldering Materials* by Jasbir Bath, Gordon Clark, Tim Jensen, Renee Michalkiewicz and Brian Toleno published in the 2011 IPC APEX conference proceedings.

Add New B-12 Paragraphs

B-12 Creep Corrosion IPC round-robin testing is underway to evaluate creep corrosion. With increasing adoption of lead-free PWB surface finishes, along with increasing product deployments in more corrosive environments, the electronics industry is observing increased occurrences of corrosion-induced product failures. Particularly, creep corrosion on immersion silver has been observed to cause product failures after very short service periods in G2 (Moderate severity level with copper corrosion rate between 30 and 100 nm [0.00118 mil and 0.00393 mil] per month as defined in ISA-S71.04-1985, “Environmental Conditions for Process Measurement and Control Systems: Airborne Contaminants.”) and worse environments, in some cases less than one year. Creep corrosion is the mass transport process in which solid corrosion products (typically sulfide and chloride) migrate over a surface without the influence of an electric field. First, a site is required for creating corrosion product, for example ImAg or OSP plated pads. Additionally, the surface between the pads has to be able to support creep of the corrosion product which will eventually cause an electrical short circuit between adjacent pads. Neither clean FR-4 nor clean solder mask surfaces support creep of copper sulfide, the typical creeping species observed in field failures. However, residues left on the surface by certain types of fluxes form a surface that allows for creep and are highly active for supporting creep of copper sulfide corrosion product.

The simulation of creep corrosion in the laboratory has to take the highly surface sensitive nature of creep corrosion into consideration. Mixed flowing gas testing can simulate environmental conditions in the global market place and has been successfully used previously to generate creep corrosion on electrical contacts (metallic surface) and integrated circuits (dielectric surface). Recently, creep corrosion was successfully reproduced on printed circuit boards using mixed flowing gas (MFG) testing. The previous inconsistency in generating creep corrosion on ImAg and OSP coated samples using MFG lies in the failure to recognize the highly surface sensitive nature of creep corrosion. Test vehicles containing only surface finishes and solder mask without going through the assembly process are not appropriate samples for generating and understanding creep corrosion, as clean FR4 and solder mask surfaces do not support creep corrosion. Searching for creep corrosion resistant PWB final finishes and fluxes should be done on an assembled board with solder mask and flux. The MFG test provides a viable and realistic accelerated aging test for creep corrosion. IPC 3-11g is currently conducting round robin test to verify the validity of using MFG for simulating creep corrosion and develop next generation standard corrosion test for electronics.

1. C. Xu, J. Smetana, J. Franey, G. Guerra, D. Fleming, W. Reents, D. Willie, A. Garcia I., G. Encinas and X. Jiang, “Creep Corrosion of PWB Final Finishes: Its Cause and Prevention,” APEX 2009.
2. C. Xu, W. Reents, J. Franey, J. Yaemsiri and J. Devaney “Creep Corrosion of OSP and ImAg PWB Finishes,” APEX 2010.
3. IPC 3-11G Corrosion of Metal Finishes Task Group in IPC.

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